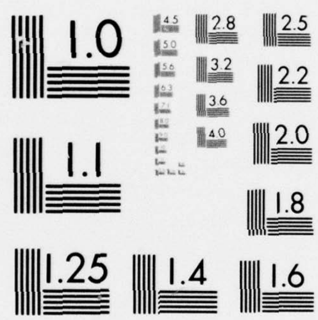
AD-A040 296 LOCKHEED ELECTRONICS CO INC PLAINFIELD N J F/G 19/1

PRODUCTION MEASUREMENT OF FUZE COMPONENTS UNDER DYNAMIC STRESS.(U)

MAR 77 A J EISENBERGER, P KASZERMAN DAAB07-76-C-0032

UNCLASSIFIED NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(12)

THIRD QUARTERLY REPORT

PRODUCTION MEASUREMENT OF FUZE COMPONENTS UNDER DYNAMIC STRESS

11 NOVEMBER 1976 - 10 FEBRUARY 1977

CONTRACT NUMBER DAAB07-76-C-0032

See a036252

PLACED BY

U.S. ARMY ELECTRONICS COMMAND
PROCUREMENT AND PRODUCTION DIRECTORATE
COMMUNICATION SYSTEMS PROCUREMENT BRANCH
FORT MONMOUTH, NEW JERSEY 07703

CONTRACTOR

LOCKHEED ELECTRONICS COMPANY, INC.
U.S. HIGHWAY 22
PLAINFIELD, NEW JERSEY 07061

Approved for public release; distribution unlimited.

This project has been accomplished as part of the US Army Manufacturing and Technology Advance Production Engineering Program, which has as its objective the timely establishment of manufacturing processes, techniques or equipment to insure the efficient production of current or future defense programs.

THIRD QUARTERLY REPORT

PRODUCTION MEASUREMENT OF FUZE COMPONENTS
UNDER DYNAMIC STRESS

11 NOVEMBER 1976 - 10 FEBRUARY 1977

CONTRACT NUMBER DAAB07-76-C-0032

PLACED BY

U.S. ARMY ELECTRONICS COMMAND
PROCUREMENT AND PRODUCTION DIRECTORATE
COMMUNICATION SYSTEMS PROCUREMENT BRANCH
FORT MONMOUTH, NEW JERSEY 07703

CONTRACTOR

LOCKHEED ELECTRONICS COMPANY, INC.
U.S. HIGHWAY 22
PLAINFIELD, NEW JERSEY 07061

Approved for public release;
distribution unlimited.

This project has been accomplished as part of the US Army Manufacturing and Technology Advance Production Engineering Program, which has as its objective the timely establishment of manufacturing processes, techniques or equipment to insure the efficient production of current or future defense programs.

See 1473

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Destroy this report when it is no longer needed. Do not return it to the originator.

PRODUCTION MEASUREMENT OF FUZE COMPONENTS

UNDER DYNAMIC STRESS

THIRD QUARTERLY REPORT

11 NOVEMBER 1976 - 10 FEBRUARY 1977

OBJECT OF STUDY: DEVLOPMENT OF A COMPUTER CONTROLLED AUTOMATIC TESTER, CAPABLE OF TESTING AND TRIMMING THICK FILM ADJUSTMENT CIRCUITS AT THE RATE OF 3,000/HOUR

CONTRACT NUMBER DAAB07-76-C-0032

PREPARED BY

ARTHUR J. EISENBERGER
PHILIP KASZERMAN

ABSTRACT

During the third quarter, the major components of the test station were built, assembled, and successfuly checked out at the vendors' plants. These components consisted of the following subsystems:

- Computer control
- Stimulus
- Measurement
- Interface
- Laser Trimmer

The first four subsystems were integrated and checked as a total system by Hewlett-Packard. The tests included a complete check of the software operating system, as well as a test of all peripheral hardware. The laser trimmer was tested on a stand-alone basis using simulated computer inputs. A simulation of the real-time amplifier test program was begun. The main-line program was coded and debugged. The design of the revised fuze oscillator and amplifier circuitry was completed, and prototype capacitors and chip resistors were fabricated and analyzed.

CONTENTS

ILLUSTRATIONS

1. PURPOSE

The purpose of this program is to develop a dynamic test and correction system, capable of high-speed operation, for electronic assemblies. The circuits selected for verification under this contract are the oscillator and amplifier assemblies of the M732 Fuze. The contract requires that 3,000 units of each assembly be delivered, of which 2,900 have been trimmed to meet the specifications. The required test rate is 3,000 an hour.

2. NARRATIVE AND DATA

2.1 INTRODUCTION

During the third quarter, the major components of the test station were built, assembled, and successfully checked out at the vendors' plants. The computer control, stimulus, measurement, and interface systems were tested at the Hewlett-Packard facility in Cupertino, California. These tests were witnessed by Lockheed Electronics Company, Inc. (LEC) personnel. These tests will be repeated, after delivery, at the LEC plant as the final acceptance procedure. The computer control tests consisted of individual checks on all the elements of the operating system and associated programs such as the file manager, editor, and program compilers. The hardware peripherals were tested using Fortran driver programs and checking with actual hardware measurements at each output point. The laser trimmer was checked out at the Quantrad plant in El Segundo, California. Computer commands were simulated by a test device. Beam positioning, laser optics, interface, laser status, and laser cutting ability were successfully tested.

A simulation of the real-time amplifier test program was begun, and was partially completed. A main-line routine was written and debugged. Calls to the subroutines were included, and the subroutines were identified.

All components and subassemblies necessary to fabricate oscillator and amplifier units (with two minor exceptions) have been released for prototype and/or final assembly.

2.2 FUZE REDESIGN

The progress made in releasing components during the third quarter is shown in the revised oscillator and amplifier assembly

family trees in Figures 1 and 2 (refer to Figures 1 and 2 in the Second Quarterly Report for a comparison). All components and subassemblies necessary to fabricate oscillator and amplifier units, with two minor exceptions, have been released for prototype and/or final assembly.

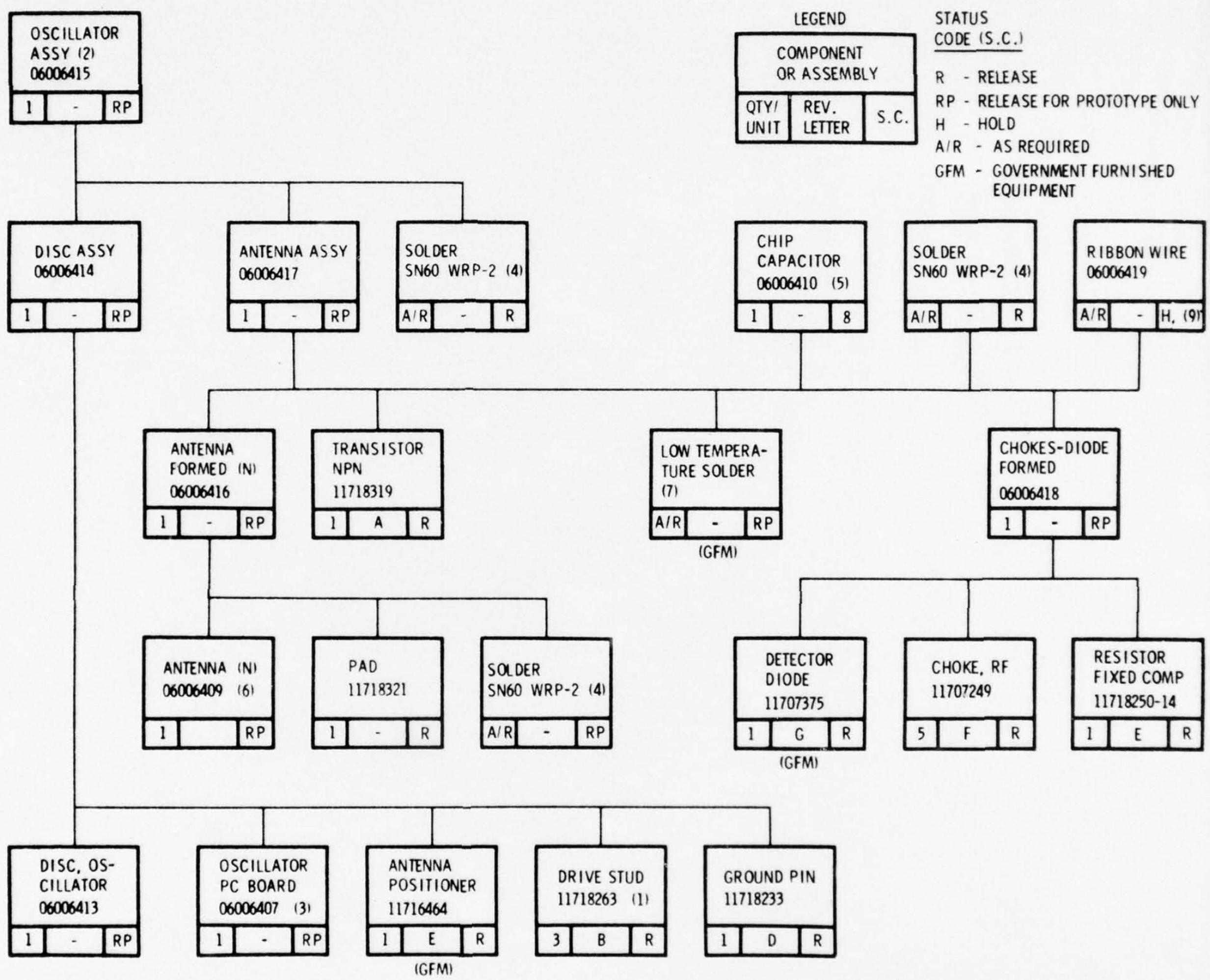
2.2.1 *Oscillator Chip Capacitor*

A number of capacitor chips in the preliminary design were saw-cut from the fired array on the master substrate, and mounted on aluminum adapter plates. These plates, in turn, were mounted into the testing fixture, and trimming cuts were performed on the chips at the distance anticipated within the test chamber. An .003-wide kerf in the gold film was obtained using a relay lens and the following laser settings (see Figure 3):

- Lamp current - 22.5 amps
- Iris - 256; Spot - .080
- Overlap - medium (50 percent)
- Repetition rate - 5 kilohertz
- Trim speed - 1 inch per second; slew speed - 4 inches per second

It was necessary to incorporate a second light source within the chamber to observe the metallized pattern and locate the starting point, which does not appear to pose any mechanical or electrical problems. Computer control was simulated by introducing the final position coordinate and executing the *go to* command.

The original chip-capacitor design described in the first quarterly report was redesigned to provide four binary-valued capacitances; thus, 16 equal steps are available instead of the equal four-increment version. Two separate designs are presently being constructed, using different fringing-capacitance criteria. One criterion is based on the result of the original experimental capacitance-testing data, and the other is based on theory. Test samples will be evaluated and modified, as required, to provide



NOTES:
1. PARALLEL GROOVE CONFIGURATION REQUIRED.
2. SCHEMATIC AND PARTS LIST 06006408 ALSO RELEASED.
3. ARTWORK 06006412.
4. PER QQ-S-571.
5. ARTWORK 06006410.
6. ARTWORK 06006409.
7. ALPHA INDIUM ALLOY NO. 1 OR EQUIVALENT.
8. TWO CHIP-CAPACITOR DESIGNS HAVE BEEN RELEASED FOR FABRICATION AND PRELIMINARY TESTING BEFORE PROTOTYPE RELEASE.
9. WILL BE CHOSEN WHEN FIRST PROTOTYPE OSCILLATORS ARE FABRICATED.

Figure 1. ECOM Oscillator Assembly Family Tree (Revision 2)

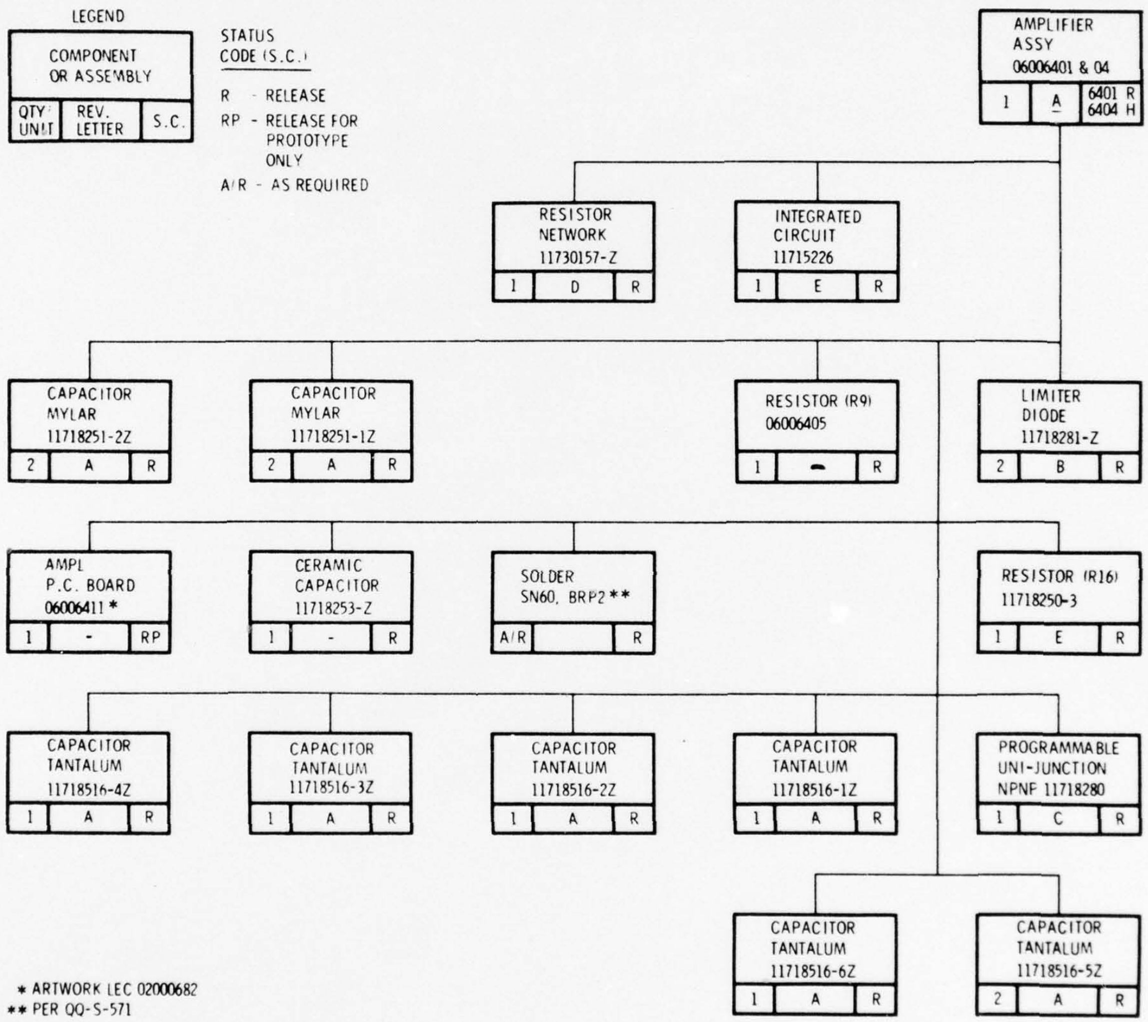


Figure 2. ECOM Amplifier Board Family Tree (Revision 2)

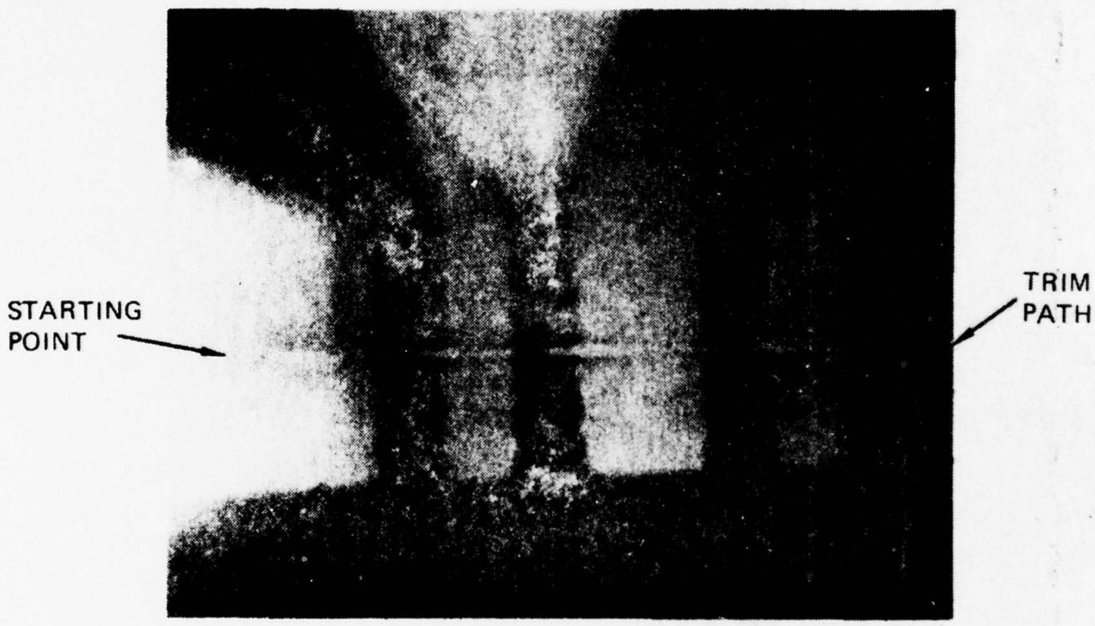


Figure 3. Capacitor Laser Trim (.003 kerf)

the needed capacitance. The starting-point locator has been centralized to reduce initial slewing time. Artwork has been completed (see Figure 4), and samples will be available during the fourth quarter.

2.2.2 *Oscillator Ribbon Wire*

A short piece of rectangular* ribbon wire is required to connect the ceramic chip capacitor to the major oscillator circuitry. Several commercial wires are readily available at LEC. Selecting a specific type will be made by the time the first prototype units are ready for assembly.

2.2.3 *Trimmable Resistor (Amplifier Gain Adjustment)*

Statistical data on 1 kilohm per square thick-film resistor material (from six different vendors), subjected to two different firing cycles, was accumulated and analyzed (see Table 1). LEC's objective was to achieve multisources of material for a standard firing cycle. The distribution spread is significant in determining which material would be most predictable from trimming and reliable design standpoints. Several conclusions (see Figure 5) can be drawn at this point, as follows:

- High resistance values can be produced by the following:
  - Using termination conductor with higher platinum content
  - Using fritless (reactively bonded) termination material
- Vendors can be ranked as follows:
  - Cermalloy - most flexible; tightest distribution
  - Electro-Science Laboratories - Close to nominal; good distribution
  - Englehard - close to nominal; good distribution

*The length of the wire is about 0.100 inches; the width is 0.050 to 0.075 inches.

Table 1. As-Fired Resistor Values (RNOM = .695 kilohms)

Vendor	Resistor Ink	Conductor Ink	Firing Profile (See Note 1)	R_{range} Min	R_{range} Max	R_{AVG}	36 Limits Min	36 Limits Max	C.V. Percent (See Note 2)	Thickness (mils) Dried	Thickness (mils) Fired
Cermalloy	2300	4100	A	.585	.612	.611	.566	.656	2.45	0.8	0.35
			B	.714	.783	.745	.685	.805	2.65	0.8	0.35
			C	.616	.690	.645	.585	.705	3.10	-	-
			D	.480	.542	.507	.447	.567	3.94	0.9	0.4
Electro-Science Laboratories	2913	9597	A	.721	.857	.777	.693	.861	3.60	0.8	0.35
			B	.560	.649	.602	.521	.683	4.48	0.8	0.35
			C	.641	.747	.688	.598	.778	4.36	-	-
Engelhard	A3003	A3147	A	.631	.755	.688	.601	.775	4.20	1.0	0.7
		A3058	A	.687	.851	.773	.632	.914	6.08	.9	0.5
		A3147	B	.613	.681	.638	.578	.698	3.13	1.0	0.7
		A3058	B	.632	.722	.674	.590	.757	4.15	0.9	0.5
		A3147	C	.796	.984	.871	.736	1.006	5.55	-	-
		A3058	C	.939	1.11	1.001	.884	1.118	3.90	-	-
DuPont	4931	9770	A	.752	.854	.800	.722	.878	3.25	1.1	0.6
		9770	B	.774	.881	.838	.760	.916	3.10	1.1	0.6
		9770	C	.616	.680	.648	.588	.708	3.09	-	-
Thick Film Systems	850-102	3412	A	.430	.480	.449	.407	.491	3.12	0.8	0.35
		3709	A	.353	.403	.378	.333	.423	3.97	0.8	0.35
		3412	B	.407	.470	.434	.380	.488	4.15	0.8	0.35
		3709	B	.348	.401	.369	.330	.408	3.52	0.8	0.35
		3412	C	.406	.457	.429	.384	.474	3.5	-	-
		3709	C	.359	.435	.399	.336	.462	5.26	-	-
EMCA	5013-1	4249	A	.838	1.03	.958	.820	1.096	4.80	0.8	0.4
			B	.811	.967	.887	.767	1.077	4.51	0.8	0.4
			C	.830	.978	.897	.798	.966	3.67	-	-

NOTES:

1. A=850°C - 2 in/min (Lindberg) B=850°C - 3 in/min (Lind) C=875°C - 3 in/min (Hayes) D=875°C - 3 in/min (Lind)
2. C.V. = Coefficient of variation, X (MEAN) ÷ σ (65 percent distribution limit)

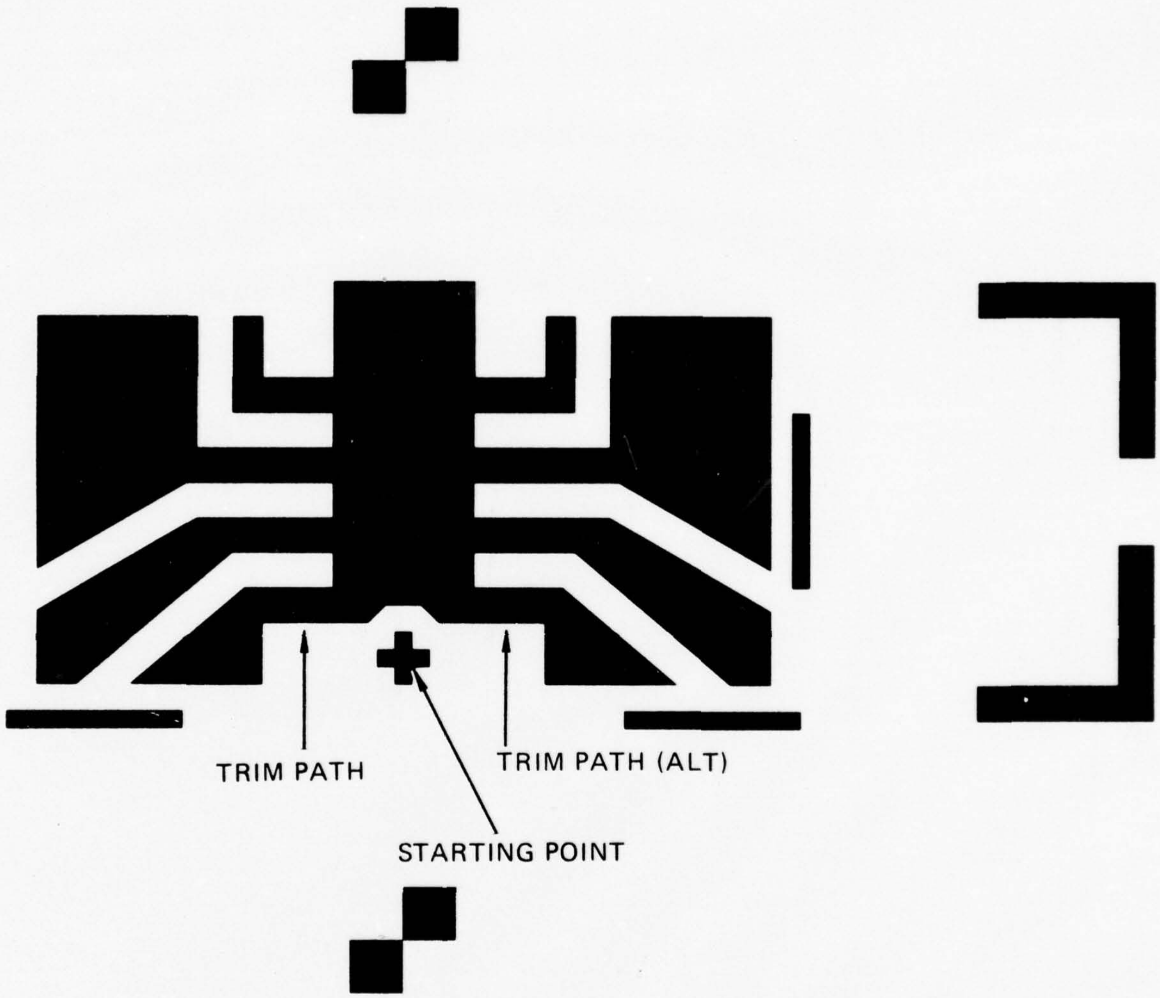


Figure 4. Trimmable Capacitor Pattern (Binary Ratio)

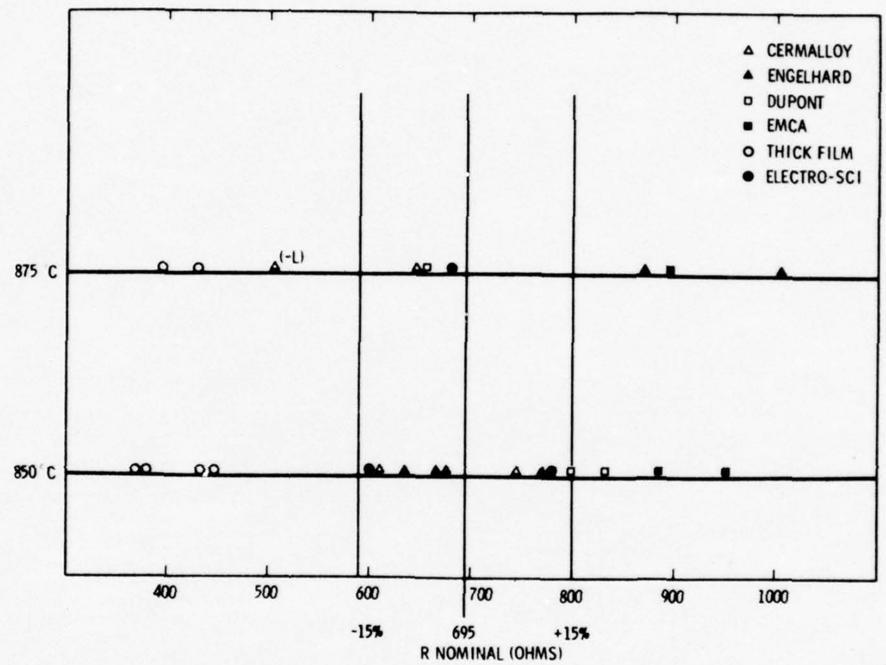


Figure 5. Resistor Chip As-Fired Mean Values

- DuPont - somewhat high; good distribution
- Thick Film Systems - very low values; good distribution
- EMCA - very high-fired values; fair distribution

2.2.4 *Laser Trimming*

A substrate array of resistor patterns were placed on the shuttle-feed mechanism, and a number of cuts were made during the check-out procedure. One resistor pattern was used to optimize the cutting parameters and simulate trimming under computer control. Figure 6 shows the back-lighted resistor plunge and shadow cuts made under computer control. Figure 7 shows the same resistor using reflected light and a third track, which did not penetrate the film because of insufficient laser power. Figure 8 depicts another resistor, which suffered surface damage because of excessive laser power and improper rep rate for a given trimming speed. The successful laser parameters used to produce a 2-mil kerf were as follows:

- Lamp current - 18 amps
- Iris - 225; spot - .300
- Overlap - medium (50 percent)
- Repetition rate - 5kHz
- Trim speed - 0.5 inches per second
- Slew speed - 4 inches per second

2.3 SYSTEM CHECKOUT

The test station system is a third-generation system consisting of the following major elements:

- Computer
- Computer-generated stimuli
- Computer-controlled sampling system
- Computer-controlled interface

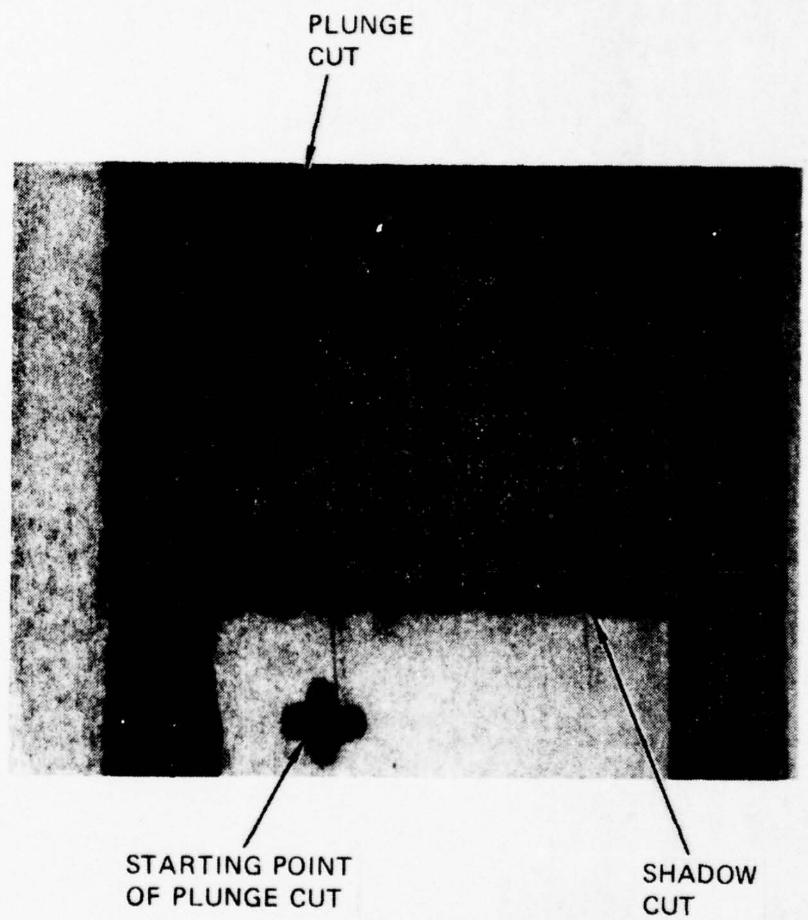


Figure 6. Back Lighted View of Resistor Cuts

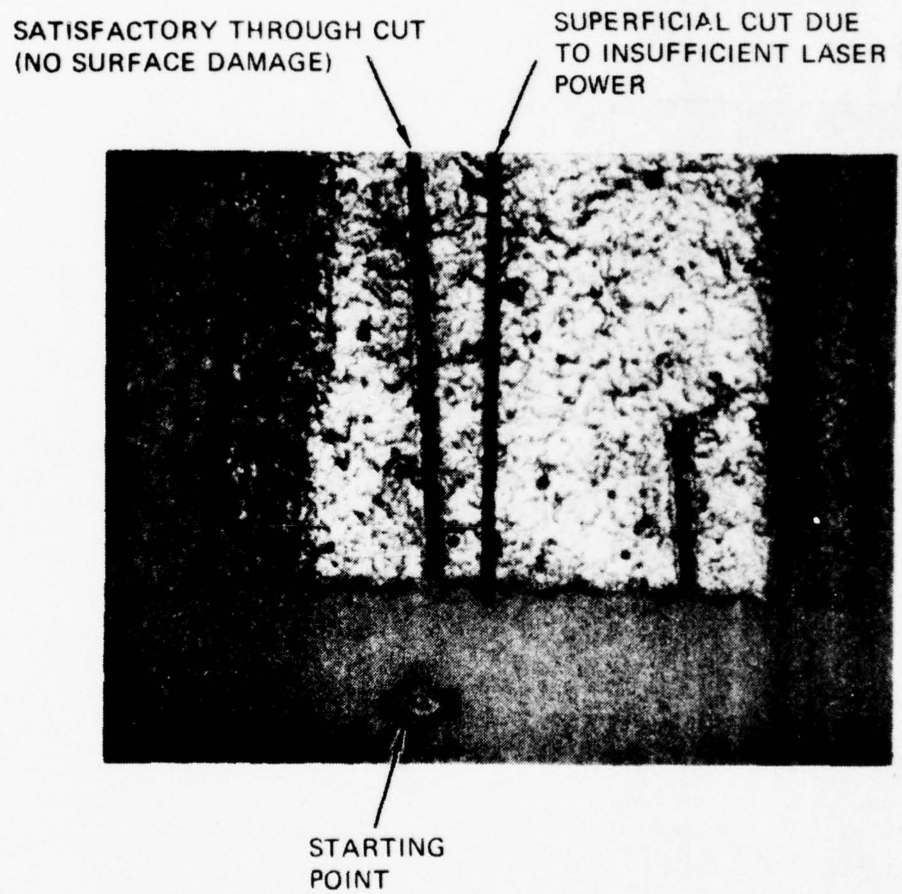


Figure 7. Top Lighted View of Resistor Cuts

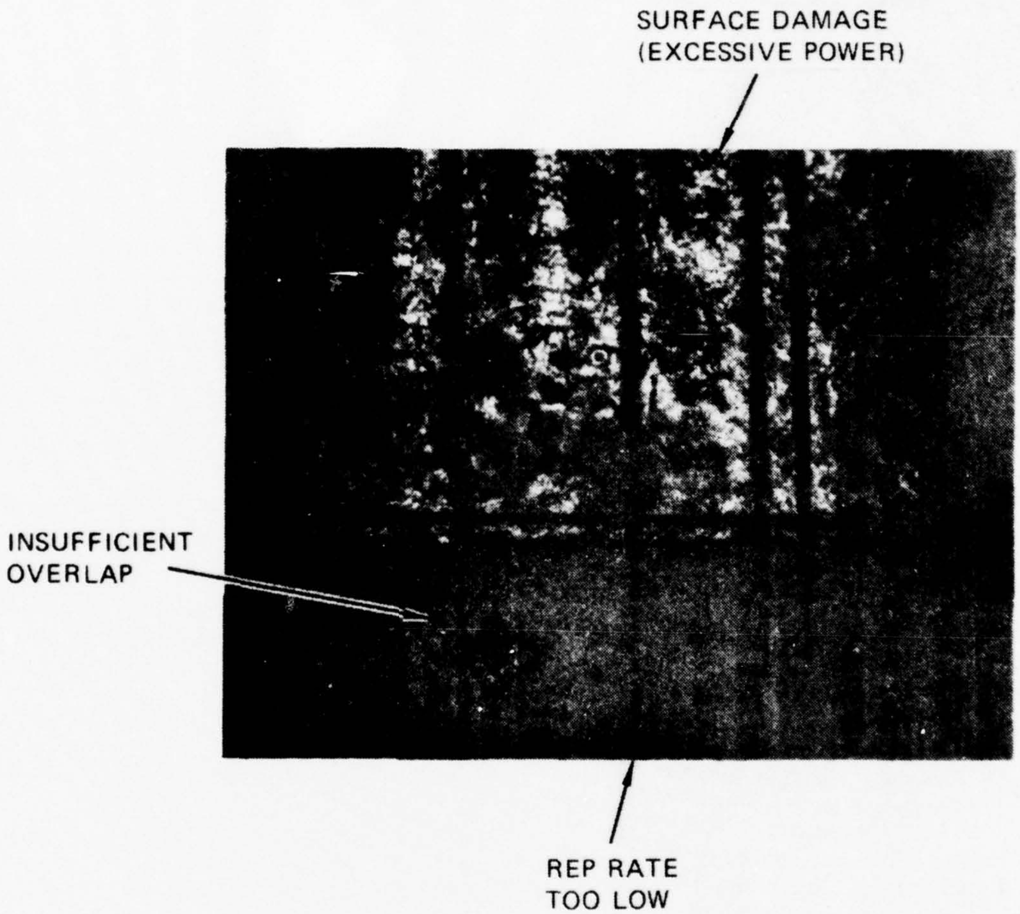


Figure 8. Unsatisfactory Laser Cuts on Thick-Film Resistor

- Computer calculation of parameters from sampled data
- Computer-controlled laser trimmer

By adding the laser to the third-generation test system, a real-time, computer-controlled trim capability has been realized.

During the first quarter, a conceptual system was designed (see Figure 9). During the second quarter, specific hardware was chosen and ordered. Figure 10 indicates the details of the system except for the laser trimmer. This portion of the system was checked out at the Hewlett-Packard factory in Cupertino, California. The tests consisted of separate checks on the operating system and integrated software-to-hardware tests for each peripheral device and card. The operating system, consisting of the software, disk, TTY, and high-speed paper tape reader, was exercised by first reading in diagnostic programs from the paper tape reader. The TTY was automatically checked since it was used as the system console to enter commands to the diagnostic programs, and was used by the computer as the output printer device. The disk and its setup was checked by writing and reading to it. The specific elements of the operating control system (i.e., real-time executive, file manager, and editor) were exercised by being called, and by having the operator enter commands controlled by each one. Programs written in Fortran, Algol, and Assembly language were compiled and run; these results were compared to known results.

Each peripheral was checked by either writing to it or reading from it. Each pacer was checked by setting it for a specific rate, reading a fixed number of words, and then checking the elapsed time by using the internal clock. The analog multiplexer (electronic switch) and last address detector were checked together by putting known fixed voltages on the switch points, commanding the switch to read through several cycles, and then checking the numbers against a table of known correct values. While the high-level multiplexer was checked, the A/D and sample-hold voltages were also checked since the voltages on the switch

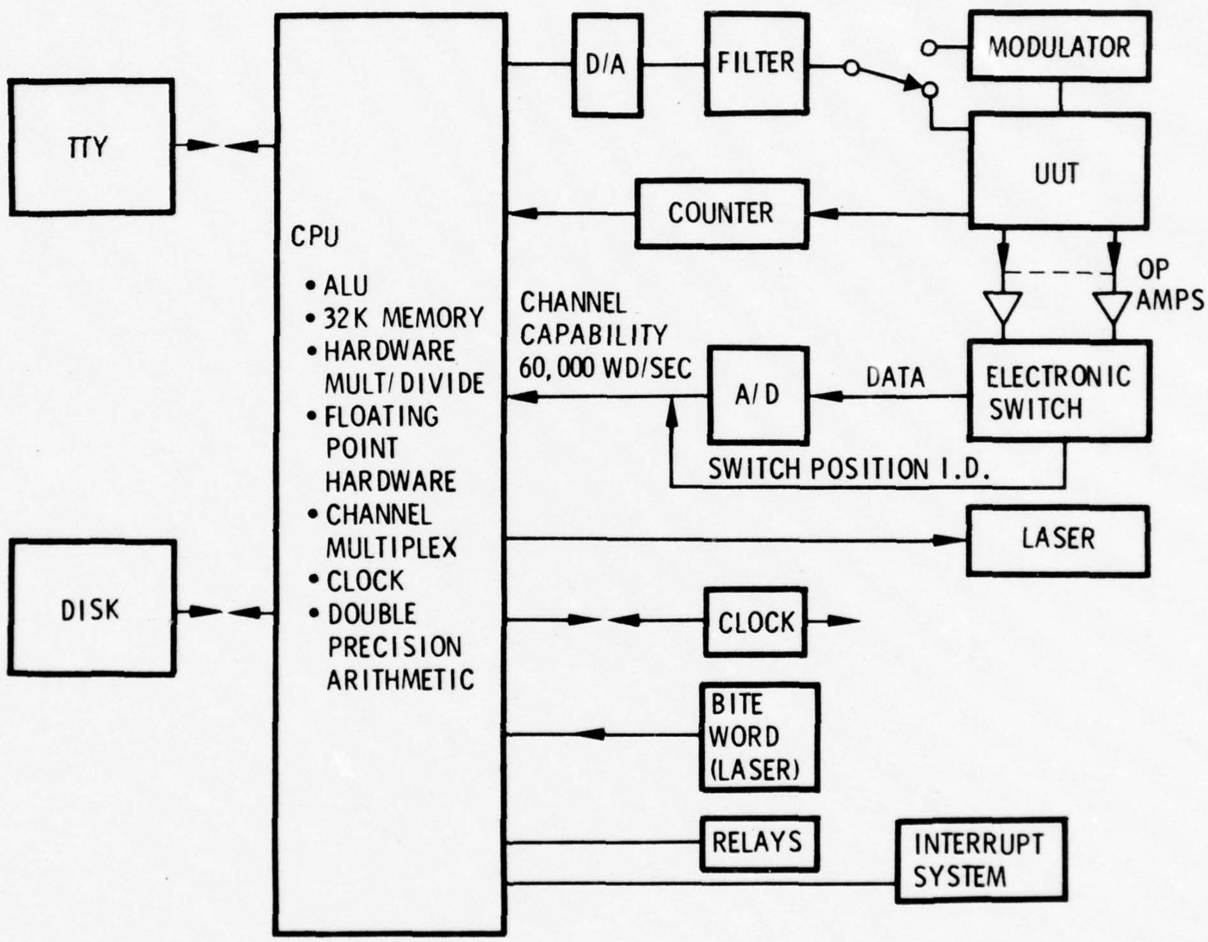


Figure 9. Test and Correction System

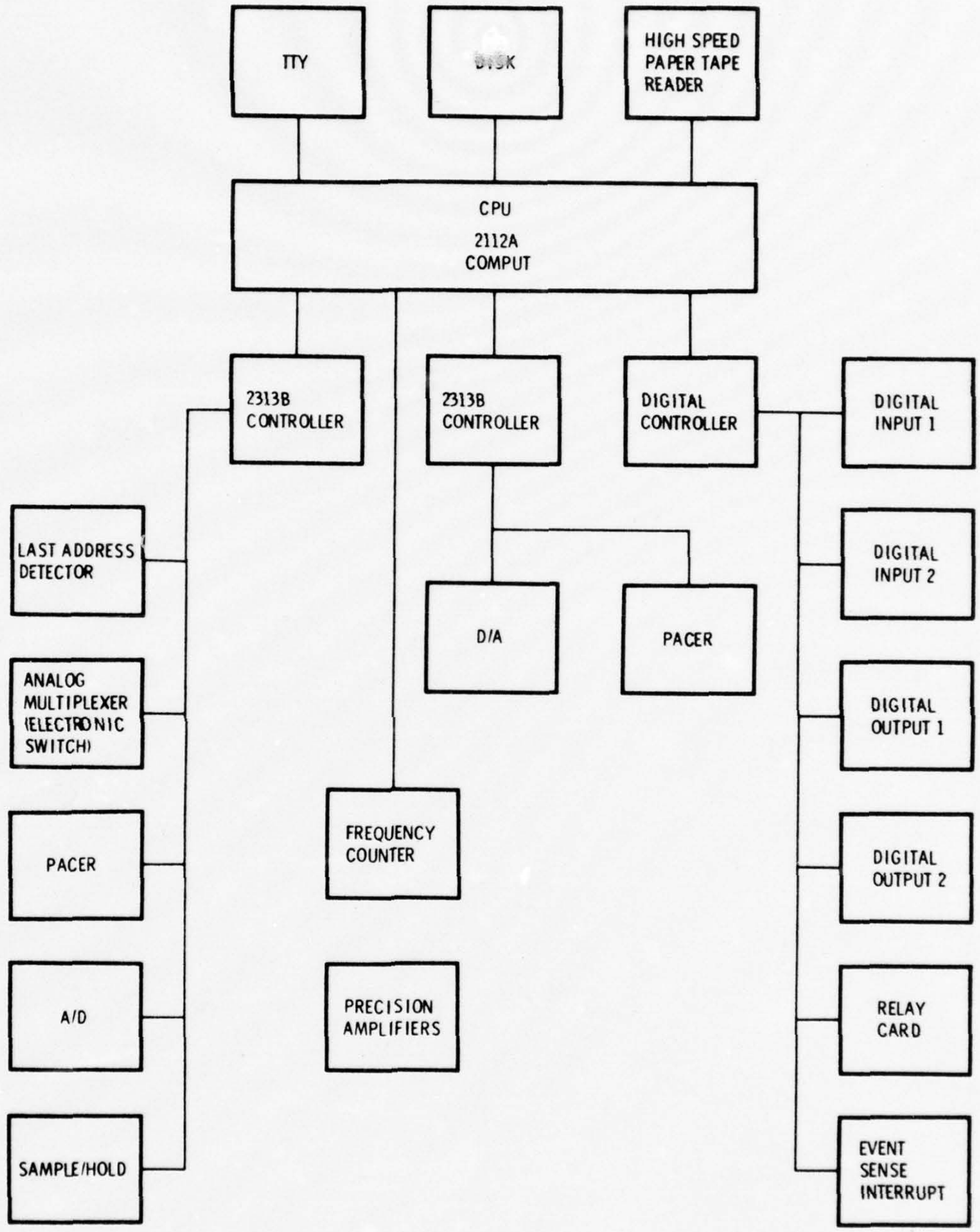


Figure 10. Computer and Computer Peripherals

had to be sampled, held, and converted to a digital number before being read by the computer. The D/A voltage was checked by outputting two different digital values from the computer and then checking (with a voltmeter) that the correct analog voltages appeared at the output of the D/A.

The cards connected to the digital controller were also tested. The digital input cards were tested by applying alternate zeros and ones to the input, reading from the card, and then comparing the card to a stored correct value. The test was repeated with alternate ones and zeros. The digital output cards were tested by successively outputting alternate zeros and ones, alternate ones and zeros, and then checking the output of the cards. The relay card was tested by commanding each relay to open and close, and then physically checking to be sure that this did take place. The event-sense interrupt was tested by energizing each of the 12 bits in succession, and checking that the computer program was indeed interrupted, and had jumped to an interrupt subroutine.

Final acceptance tests will take place at LEC during the fourth quarter.

Fuzes have been tested and the results have been checked against the model described in the Second Quarterly Report. The results of the comparison are described in Appendix A.

2.4 LASER TRIMMER CHECKOUT

The laser trimmer system was tested at the Quantrad plant in El Segundo, California. A Quantrad-supplied test procedure was used to check the laser performance, laser optics, beam positioner, interface, and laser status. The unit successfully passed all tests. The paragraphs that follow provide a description of this checkout procedure.

Laser. - Place the laser in operation, as specified in Section 2.3 of the operating manual. Remove the light shield between the

laser output mirror and the optics box, and mount Coherent Radiation Model 205 detector head in the beam path. Connect the detector head to Coherent Radiation Power Meter Model 201, turn on laser, and perform the following output power measurements:

Q-switch rf off (safety shutter held open to defeat the interlock, and no aperture in the laser) 30 watts (at 21 amps lamp current)

Q-switch as above but with .060-inch aperture 4 watts minimum (10 watts - actual)

To determine that the latter condition is indeed the TEM_{00} mode, observe the defocused beam at the output objective position with an infrared viewer. The spot should be round with a single maximum in the center, and perform the following measurements:

Q-switch rf on, repetition rate set at 5 kilohertz:

2.5 watts output minimum

actual $\begin{cases} \text{3.0 watts at 15 amps} \\ \text{6.5 watts at 20 amps lamp current} \end{cases}$

Laser Optics. - Set up laser-trim parameters to obtain the smallest spot size, using the aperture and spot-size controls. Trim a sample thick-film substrate using a 2-inch focal length objective, and verify that the spot size can be varied between .001 and .005 inches. Elevate the substrate with a .005-inch shim, and verify that the spot size does not change, confirming the field depth of .010 inches. Install relay lens in table top, mount sample thick-film gold sample at 6.5-inch distance below table, and perform trim. Elevate substrate with .060 shim and repeat.

Beam Positioner. - Connect the beam positioner and place it in operation according to Section 2.4 of the 1021 manual. With the control console in the manual mode, operate the joystick to the four extremes of motion. Verify that the system stops at the limits, and that the limits are 2.000 inches apart by making scribe marks on an anodized aluminum plate and measuring with a steel rule. Command the system to the center (X=2048, Y=2048),

and make a mark with the laser. Modify the command to X-1024 and then to X3072, and verify that the marks are 1.000 inches apart.

Verify slew speed by connecting an oscilloscope to TP 1 on the X axis control board and observing the voltage under manual joystick control. Measure the time for a traverse of 1 inch (eight revolutions) and divide the voltage at TP 1 by this time to calibrate the tachometer. Using this calibration number, measure the peak voltage during a slew of at least .250 inches (two turn discs placement from the end point). The slew rate should calculate to 4 inches per second. Repeated slews can be performed by commanding the system to the center and turning the mode switch to manual. The system is then displaced from the center by the joystick, and the mode switch is returned to remote. The positioner will then slew to the center, and the rate is measured by the tachometer signal. Trim rates are similarly checked by commanding the trim mode.

Interface and Digital Control. - The interface is checked by means of a simulator, supplying 25 milliamperes to the inputs on which 1's are desired, and leaving open inputs for which 0's are desired. The strobe line is supplied with a 10-microsecond pulse at the same level. The command code lines are set for either an X position, Y position, or command word. The code is put online, and a strobe pulse is sent. The command code can then be changed, and another word can be sent. The interface outputs are monitored by the LEDs in series with the output lines. Connections to a compatible interface or shorting plugs must be in place to use the LED indicators. Representative addresses are commanded, and the LED indicator output is observed to demonstrate that the input command is echoed in the position returned. Command codes are verified by observing that the trim speed is enabled in trim, and that the laser is controlled by the laser enabled and laser not inhibited commands.

Laser Status. - The laser status signals are verified by introducing laser faults and observing LED indicators. Temperature faults should be simulated to avoid stress on the laser.

2.5 MODULATOR DESIGN

Figure 11 shows a block diagram of the circuitry used in conjunction with oscillator load-chamber testing. The three main functions shown are a primary power source, load chamber, and modulator. Rf signals from the test oscillator are sampled by an antenna mounted in the floor of the oscillator load chamber. The sample signal is then routed to an Rf power divider, where a single sideband (ssb) modulator offsets its frequency by a computer-generated modulator signal. The offset signal frequency and duration are controlled by the computer and converted into an analog signal by a D/A converter located in the computer console. An audio filter and buffer amplifier will be provided to produce the appropriate modulation drive level for the modulator. The Rf signal is then adjusted in amplitude and reradiated into the test fuze as the stimulus for its detector.

This circuitry is also capable of amplitude modulating a constant offset-frequency return signal. In this case, the modulator drive is generated by the computer. The offset frequency, however, is locally generated. Modulating in this manner allows amplitude modulation of the return signal with an arbitrary waveform.

Three measured test parameters are required to predict oscillator *sensitivity*, the parameter to be adjusted. They are pretune operating frequency (f_o), detector voltage, and sensitivity. Operating frequency is measured by a frequency meter located in the computer console. The detector voltage and pretune sensitivity are measured at the oscillator bias circuit as a large dc

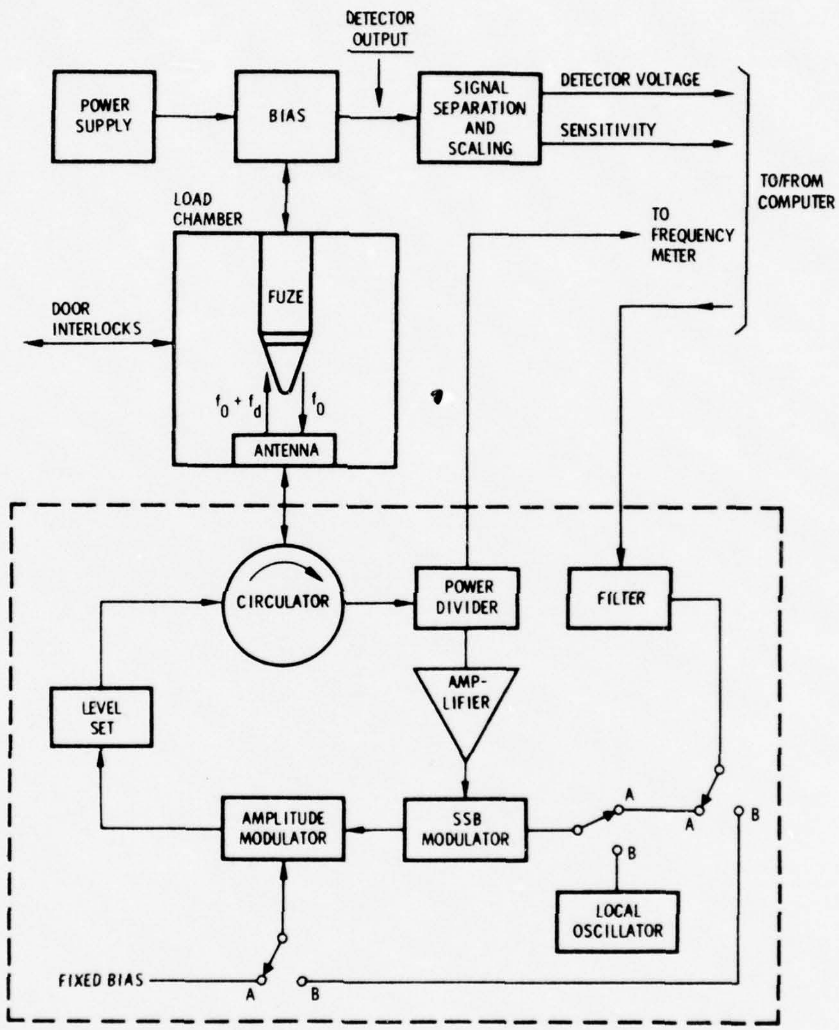


Figure 11. Modulator Block Diagram

voltage, with a low-level ac riding on top.* Detector voltage and sensitivity are measured by an A/D converter at the computer after appropriate signal separation and scaling. All three parameters must be measured accurately to properly select chip capacitors. Modulator parameters and system gain are presently being evaluated. Major components have been tentatively selected. The final choice and layout, however, will be completed during the fourth quarter.

2.6 RF CHAMBER

The rf load chamber size and its location on the laser was slightly modified. The chamber is now higher by 1.175 inches, and is equipped with an rf shield around the door, a locking handle, and a cutout (7x7 inches) in the bottom wall to accept any future variation of the rf antenna. There is also a provision to mount two additional rf loops in the upper wall of the chamber.

When the chamber door is closing, a 2-inch long guiding pin (pressed into the door and sticking out toward the chamber) will engage a proper slot in the chamber. This will prevent any possible damage to the edges of the absorbing tiles should the door become misaligned.

The closing door will also actuate two safety switches wired in series with the *Q switch* of the laser, thus providing safety interlocks on laser operation.

The chamber itself it mounted permanently to the bottom of the laser worktable; removing the chamber, while trimming the amplifier assemblies, is no longer required. This improvement is possible partly because the chamber is mounted under the laser worktable, and partly because of an optics extension (needed to

*Detector voltage levels can vary from 20 to 40 volts dc for unpotted oscillators with a small 0 to 300 millivolt rms ripple on top. This rms ripple level determines oscillator sensitivity.

obtain a 6-inch focal length), which is easily installed in, and removed from, the laser table.

It should be pointed out that the shuttle loader (a mechanism that nests and feeds the amplifier assembly during the laser trimming) must be removed from the laser table when trimming the oscillator assembly, and must be mounted again for the amplifier assembly trimming.

The design of the anechoic chamber, shown in Figures 12 and 13, is 90 percent completed. Drawings of the outer envelope of the chamber (out of aluminum), the door, and all the needed shapes of absorbing tiles that compose the inner walls of the chamber have been released for manufacturing.

The remaining drawings of the parts needed to complete the chamber are in the advanced stage of the design and detail. Long-lead purchased parts were ordered and plans for the layout of a closed area laboratory have been prepared.

2.7 SIMULATION

The simulation of the real-time amplifier test program was initiated, and the main-line routine was written and debugged. A flowchart of the program was given in the last report and is shown herein as Figure 14.

To simplify the writing and debugging, the program was divided into a main-line program and seven subroutines. Specifically, the blocks in the flowchart were converted to subroutines. A single I/O subroutine was composed of blocks 3, 4, 5, 7, 8, 9, 11, 12, 13, 17, 18, 19, 20, and 21. These blocks performed the six I/O functions described in the second report, and are summarized in Table 2. The detailed flowchart in Figure 15 shows the organization of the I/O subroutines and the portion of the main-line program that used the read-in data to calculate the parameters of the amplifier. The purpose of this particular

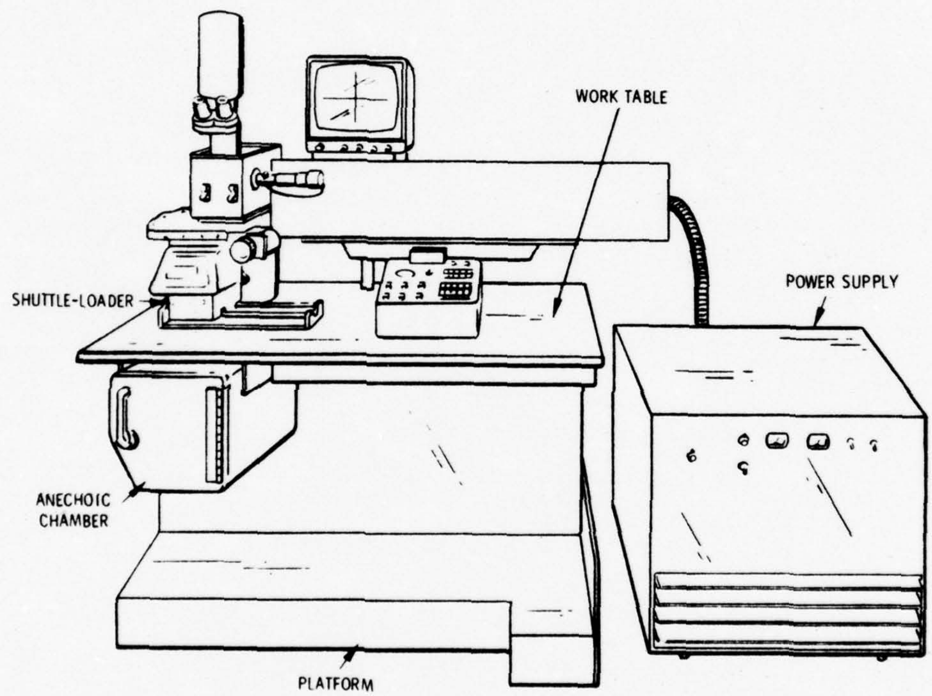


Figure 12. Laser - Trimmer Subsystem

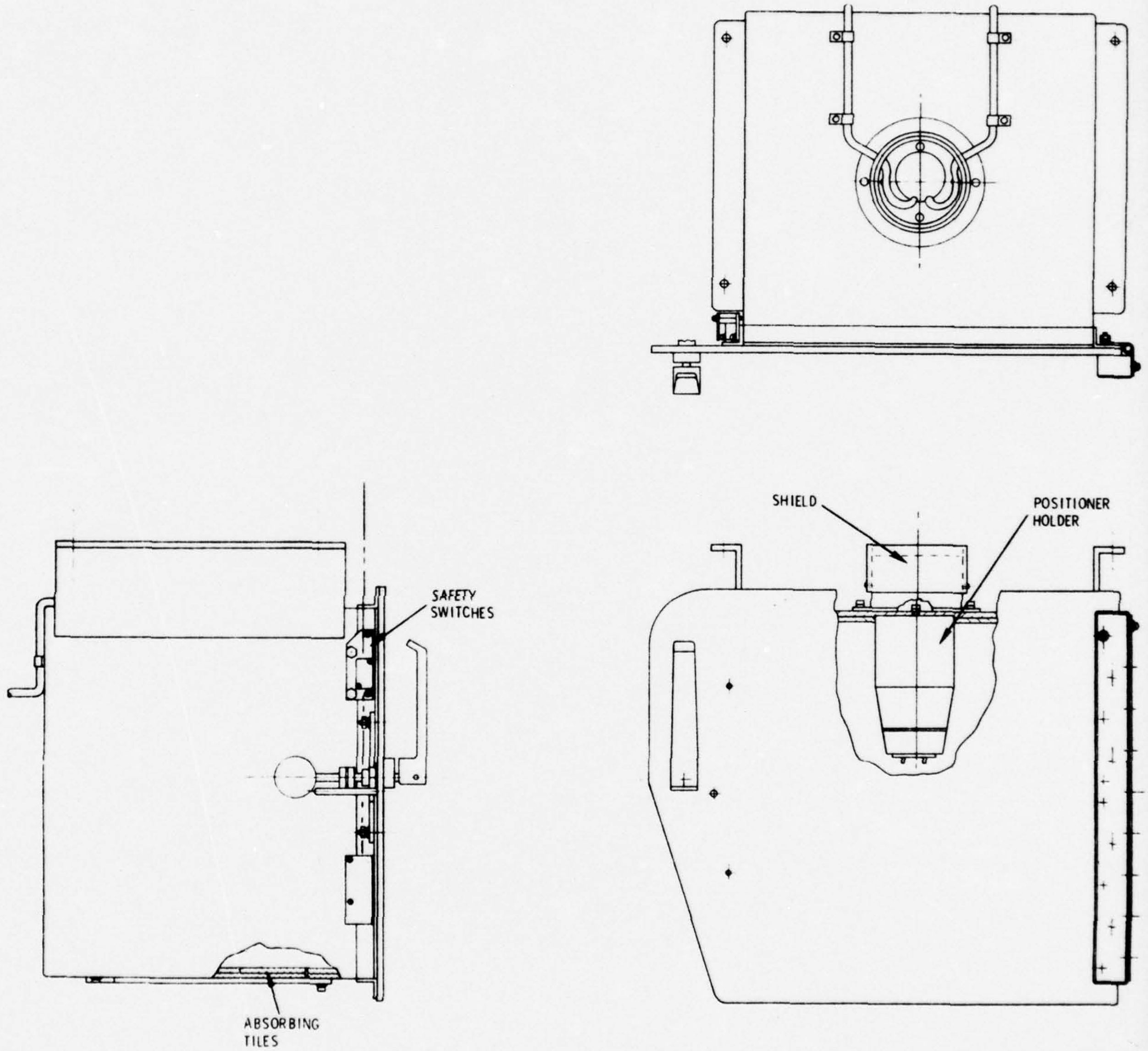


Figure 13. Rf Chamber

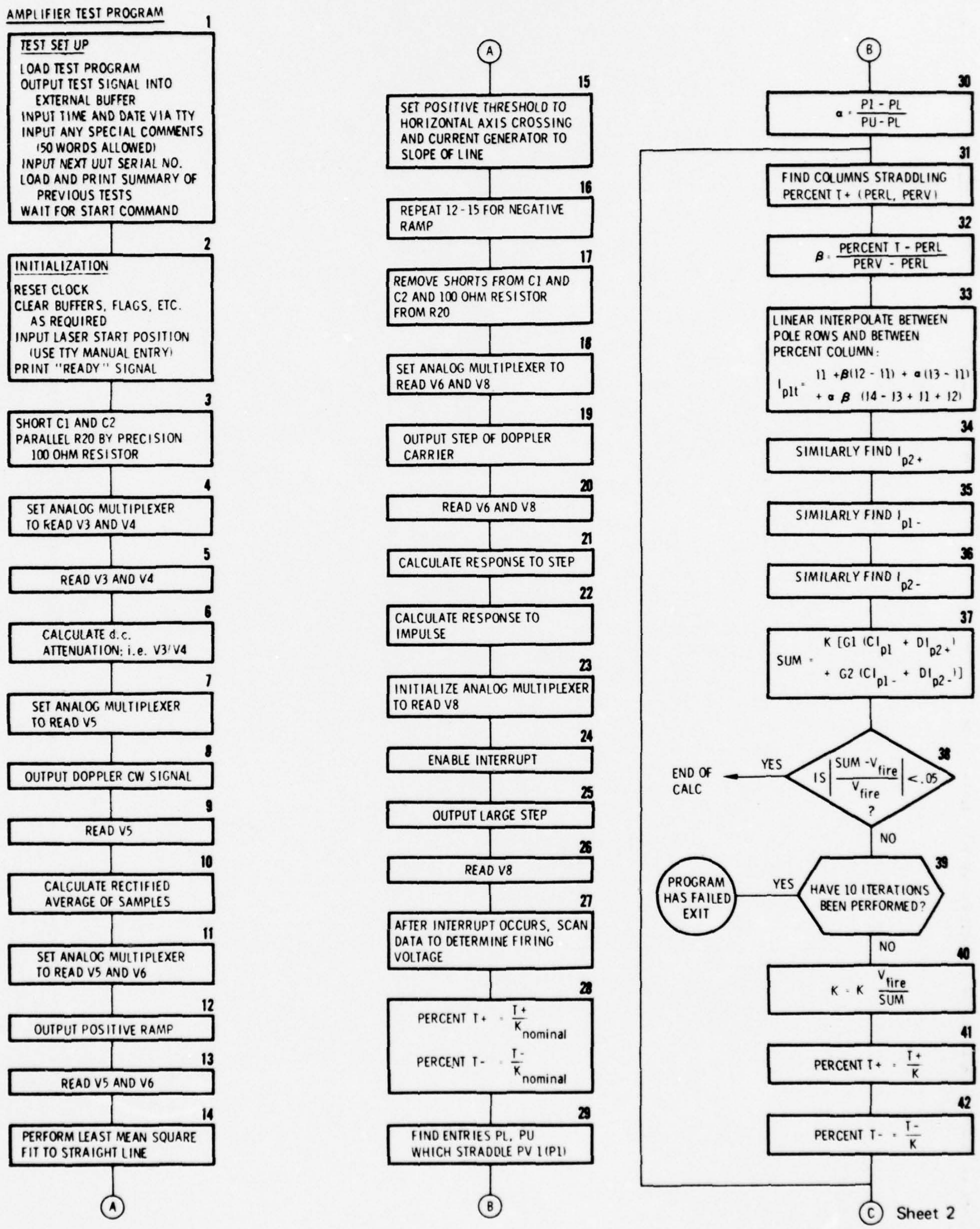


Figure 14. Amplifier Test Program (Sheet 1)

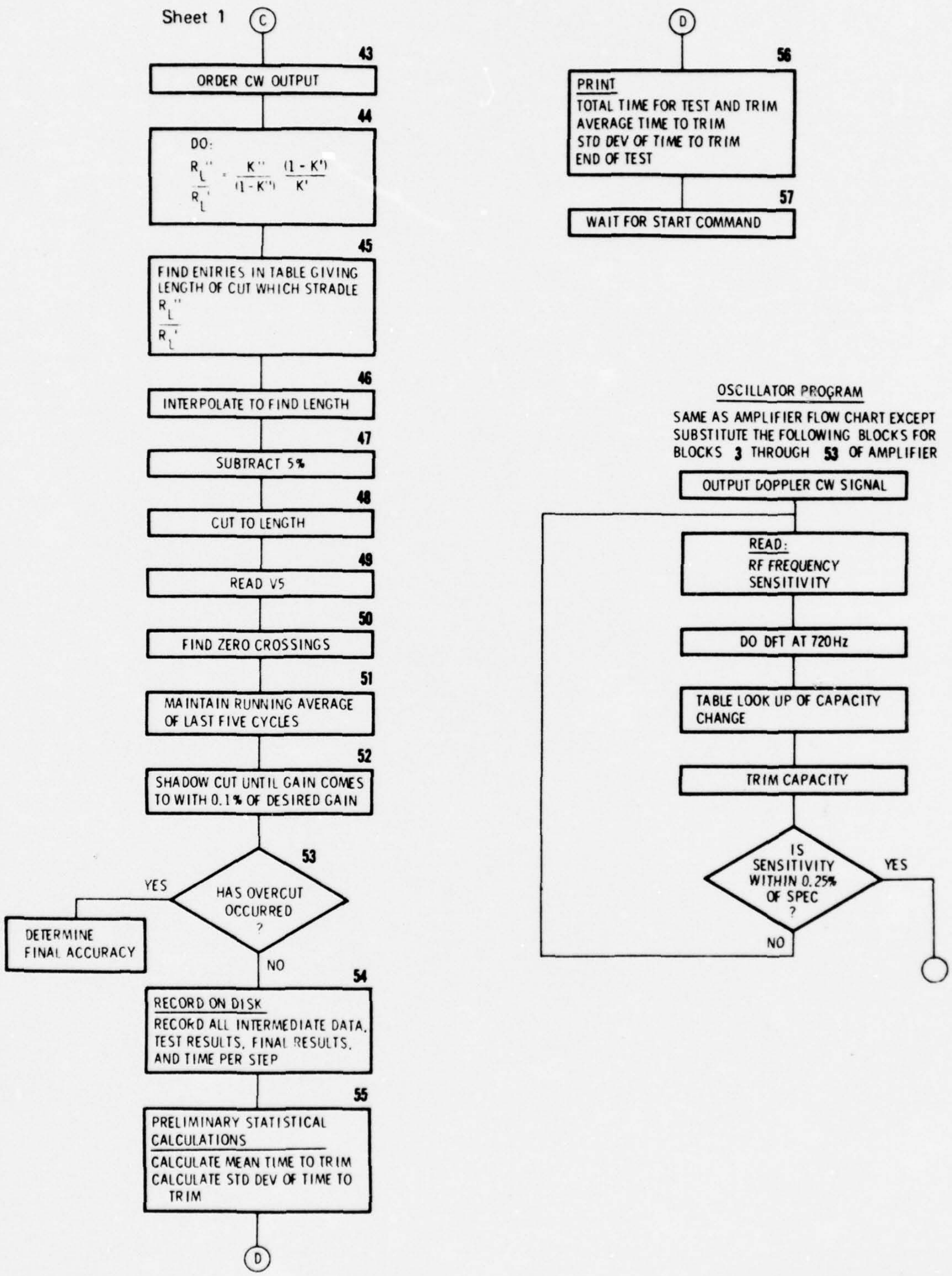


Figure 14. Amplifier Test Program (Sheet 2)

Table 2. Measured Amplifier Characteristics

Measurement Objectives	Hardware Conditions	Input Signal	Measured Voltages	Calculations
Dc attenuation of divider	Short C1,C2; parallel R20 by a small resistance	None	V3, V4	Divider attenuation
Gain to point 5	Short C1,C2; parallel R20 by a small resistance	CW	V5	Rectified average of ac
Positive and negative threshold and current generator	Short C1,C2; parallel R20 by a small resistance	Delayed positive and negative ramps at V6	V5, V6	Least mean square fit to line to give thresholds and current generators
Filter step response	Remove short from C1, C2, and small R from across	Step of carrier	V8	Preliminary calculation of step input to filter A, p1, p2 of u(t), and C and D of h(t)
SCR firing voltage	Remove short from C1, C2, and small R from across R20	Increase carrier step sign to maximum	V8	*Spike* determination at SCR gate

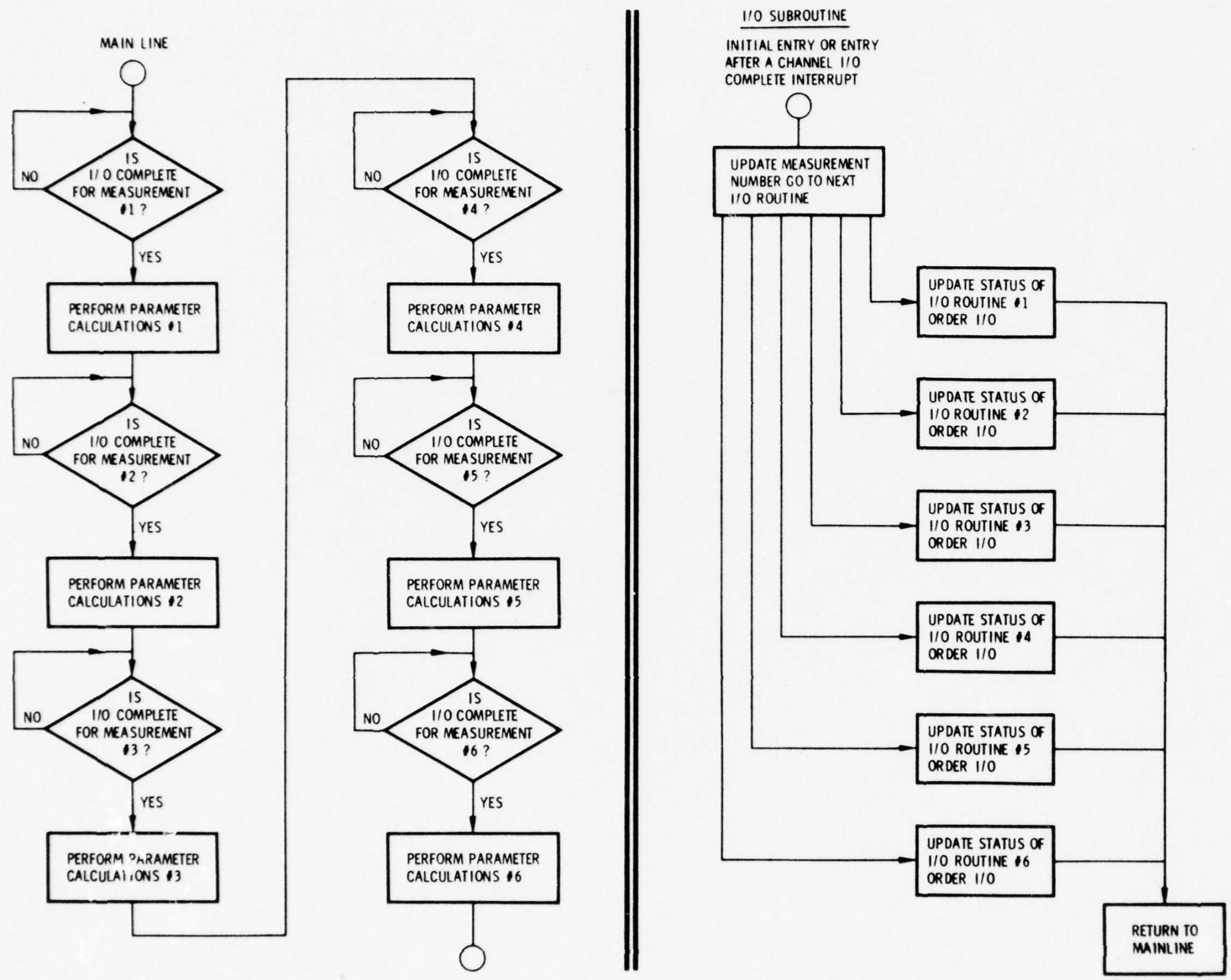


Figure 15. Measurement Flow Chart

organization was to allow continuous I/O in parallel with the calculation of the amplifier parameters. The I/O subroutine was initially entered from the main line. A measurement identification (ID) was set, and the first I/O was initiated. The program returned to the main line, while the I/O continued in parallel. When the first I/O was completed, a channel interrupt brought the program back to the I/O subroutine. It incremented the measurement ID, initiated the next I/O, and returned to the main-line program. The main-line program then checked the measurement ID and if the I/O was complete for a given measurement, the appropriate parameter calculation was performed. The I/O and main-line routine continued in parallel until the I/O required for all parameter calculations was completed.

The following calculations were assigned to subroutines:

- Least mean square fit to detector data to obtain threshold and current generators
- Discrete Fourier Transform to calculate amplitude
- Step response of filter
- Impulse response of filter
- Convolution integral
- Required length of cut for given change in gain

The main-line routine has been coded and debugged except for blocks 1, 2, 54, and 55. The first subroutine listed above (i.e., least mean square fit calculation) has also been coded, debugged, and checked out with the main-line routine.

The other subroutines have been defined within the program. Nominal values for the variables have been entered; thus, the main program can be checked out using the subroutine calls.

It is expected that most of the code for the simulation will be used for the actual real-time program. The I/O driver routines, however, will have to be written specifically for the Hewlett-Packard computer. Appendix B and C contain listings of the program and printouts of the results of an actual run.

3. CONCLUSIONS

The objectives of the third quarter were successfully met, as follows:

- The major test station subsystems were built, assembled, and successfully tested.
- 50 percent of the fuze components were received.
- A simulation of the main-line routine of the amplifier test program was written and debugged.
- Fuze redesign was completed.

4. PROGRAM FOR NEXT QUARTER

During the next reporting period, the following activites are planned:

- Integrate the complete system.
- Initiate coding of the real-time program on the test system.
- Continue fuze-prototype fabrication.
- Continue simulation effort.

5. PERSONNEL

During this reporting period, the following personnel worked on this program for the number of hours indicated.

Name	Program Function	Hours
A.J. Eisenberger	Program Manager	208
P. Kaszerman	System Engineer	248
R.F. De Mattos	Tester RF and Fuze	182
H.J. Curnan	Laser Trimmer and Fuze Microcircuits	56
G.L. Freed	Digital Components	117
U.Z. Escoli	Mechanical Design	168
A.H. Owens	Mechanical Design	24
R. Blau	Computer Modeling	44
-	Draftsmen, Machinists, Technical Publications, etc.	499

APPENDIX A

OSCILLATOR MODEL

During the third quarter, progress has occurred in two areas. First, some refinements have been incorporated in the model itself. Second, comparisons of experimental and calculated values of sensitivities have been made on a considerably larger number of oscillators.

The chief refinement in the model was that the effect of the walls of the test chamber were accounted for by representing it as a fixed phasor that alters loop impedance. Thus, for example, $\tilde{X}$ and R in Equation (11) of Appendix A of the second report, are replaced by:

$$\tilde{X} + X_x \text{ and}$$

$$R + R_x,$$

where:

$P_x = R_x + jX_x$ is the fixed phaser.

Numerically, it is necessary to evaluate P_x by means of calibration transistors (i.e., empirically, since the algorithm has too many unknowns vis-a-vis the number of equations to accomplish this in any other way). The value of P_x that is found is quite large, about 50 ohms in magnitude. This result is perhaps not too surprising when it is recalled that the walls of the test chamber, which are far from being perfectly absorbing, surround the antenna on all six sides.

Using a value of:

$$P_x = 40 - 20j \text{ ohms},$$

a comparison of theory versus experiment was made based on 24 oscillators (see Table A-1 for the results). *Condition 1* in Table A-1 refers to measurements or calculations with no capacitive pads attached; *Condition 3* means that the large parallel pad alone has been connected; and *Condition 4* means both parallel pads are in the circuit (it is planned in the very near future to extend these results to all combinations of parallel and series pads).

Except for SN9 and SN23, all of the calculated results are within approximately ±15 percent of the measured values. In general, the scatter in the calculated values is not difficult to understand: in the model, values of the circuit constants are fixed, whereas the actual values must vary from oscillator to oscillator. The implication is, therefore, that if data on the error of the original calculation were fed back into the computer, these individual variations could be corrected for. In other words, if the scatter in measured versus calculated results is indeed due to individual differences in oscillator circuit values, then a process of iterative corrections should produce rapid convergence. It is planned to test this hypothesis in the near future. It is also planned to extend the tests of the model to 100 additional transistors for which data exist on several combinations of series and parallel pads.

Table A-1. Theory vs Experiment Based on 24 Oscillators

	Condition		Sensitivity		
SN	Input	Output	Measured	Calculated	Error
1	1	4	0.174	0.164	0.010
1	4	1	0.125	0.137	0.012
2	1	4	0.198	0.198	0.000
2	4	1	0.124	0.138	0.014
3	1	4	0.156	0.143	0.013
3	4	1	0.076	0.090	0.014
4	1	4	0.158	0.154	0.004
4	4	1	0.096	0.099	0.003
5	1	4	0.155	0.140	0.015
5	4	1	0.105	0.112	0.007
6	1	4	0.147	0.141	0.006
6	4	1	0.070	0.080	0.010
7	1	4	0.145	0.141	0.004
7	4	1	0.077	0.077	0.000
8	1	4	0.148	0.132	0.016
8	4	1	0.086	0.100	0.014
9	1	3	0.167	0.141	0.026
9	3	1	0.110	0.134	0.024
10	1	4	0.167	0.154	0.013
10	4	1	0.098	0.112	0.014
11	1	4	0.163	0.178	0.015
11	4	1	0.103	0.109	0.006
12	1	4	0.131	0.119	0.012
12	4	1	0.064	0.064	0.000
13	1	4	0.158	0.158	0.000
13	4	1	0.107	0.097	0.010
14	1	4	0.180	0.168	0.012
14	4	1	0.113	0.131	0.018
15	1	4	0.179	0.172	0.007
15	4	1	0.137	0.140	0.003
16	1	4	0.171	0.173	0.002
16	4	1	0.125	0.110	0.015
17	1	4	0.129	0.138	0.009
17	4	1	0.055	0.056	0.001
18	1	4	0.149	0.134	0.015
18	4	1	0.100	0.113	0.013
19	1	4	0.180	0.168	0.012
19	4	1	0.118	0.125	0.007
20	1	4	0.164	0.151	0.013
20	4	1	0.093	0.102	0.009
21	1	4	0.161	0.175	0.014
21	4	1	0.087	0.092	0.005
22	1	4	0.172	0.176	0.004
22	4	1	0.115	0.118	0.003
23	1	3	0.155	0.122	0.033
23	3	1	0.093	0.120	0.027
24	1	3	0.152	0.157	0.005
24	3	1	0.120	-0.329	0.449

APPENDIX B

LISTING OF SIMULATION OF MAIN-LINE REAL-TIME AMPLIFIER TEST PROGRAM

```
C SIMULATION OF REAL TIME APLIFIER TEST PROGRAM
C
C          MEASUREMENT ID
C
C     ID                     NAME
C     --                     ----
C      1                DC ATTEN
C      2                RECTIFIED AVERAGE
C      3                POSITIVE THRESH AND CUR. GEN
C      4                NEGATIVE THRESH AND CUR. GEN.
C      5                STEP RESPONSE
C      6                SCR FIRING VOLTAGE
C
C
C
C
C
C  DATA DEFINITIONS
C
       COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(10))
      COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
      COMMON M1,M2,M3,M4,M5,M6
C
      COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
      COMMON CUT,TIM
C
C
C
      WRITE(9,600)
  600   FORMAT(1X,
     1 /"          MEASUREMENT ID"
     1//"     ID                  NAME"
     1/"     --                  ----"
     1/"      1         DC ATTEN"
     1/"      2         RECTIFIED AVERAGE"
     1/"      3         POSITIVE THRESH AND CUR. GEN"
     1/"      4         NEGATIVE THRESH AND CUR. GEN."
     1/"      5         STEP RESPONSE"
     1/"      6         SCR FIRING VOLTAGE",//////)
C
C
C
C  INITIALIZATION AND DATA GENERATION FOR SIMULATION PROGRAM
C
      GNOM=5.
C
C  POLE SCALING FACTORS
      SP1=1
      SP2=1.
      NNP1=5
```

```
      NNP2=5
      DELP1=5.
      DELP2=5.
      MP1=3
       MP2=3
C
      KOUNTR=10000
C
      M1=2
      M2=2
      M3=2
      M4=2
      M5=2
      M6=2
C
C  MEAS.1
C
      DTA1(1)=5.
      DTA1(2)=1.
C
      WRITE(9,601)(DTA1(I),I=1,2)
 601     FORMAT(1X,"DC ATTENUATION"/1X,2F10.2//)
C
C  MEAS2
C
      DO 10 I=1,99,2
10    DTA2(I)=10.
      DO 11 I=2,100,2
11      DTA2(I)=-10.
      WRITE (9,602)(DTA2(I),I=1,10)
 602   FORMAT(///1X,"DATA FOR POINT 5 VOLT"/1X,20(6F10.2/1X),4F10.2)
C
C
C  MEAS3
C
      DO 12 I=1,999,2
12    DTA3(I)=I
      DO 13 I=2,1000,2
13    DTA3(I)=10*I-100
C
      WRITE(9,603)(DTA3(I),I=1,18)
 603    FORMAT(///1X,"POSITIVE RAMP DATA"/1X,40(6F10.2/,1X))
C
C  MEAS4
C
      DO 15 I=1,999,2
15      DTA4(I)=-I
      DO 16 I=2,1000,2
 16    DTA4(I)= 10*I-100
C
      WRITE(9,604)(DTA4(I),I=1,18)
 604    FORMAT(///1X,"NEGATIVE RAMP DATA"/1X,40(6F10.2/1X))
C
C  MEAS5
C
      DO 20I=1,100
20    DTA5(I)=I
C
      WRITE(9,605)(DTA5(I),I=1,12)
 605  FORMAT(///1X,"STEP RESPONE"/1X,20(6F10.2/1X)/)
```

```
C
C  MEAS6
C
      DO 21 I=1,1000
21      DTA6(I)=I
C
      WRITE(9,606)(DTA6(I),I=1,12)
 606  FORMAT(///1X,"FIRE VOLTAGE DATA"/1X,20(6F10.2/1X)//)
C
C  TABLE OF CONVOLUTION INTEGRALSS
C
      DO 25 I=1,30
      DO 25 J=1,11
25      CON(I,J)=I-J+100
C
       WRITE(9,607)
 607    FORMAT(///1X,"TABLE OF CONVOLUTION INTEGRALS")
      DO 10050 I=1,5
      WRITE(9,610)(CON(I,J),J=1,11)
10050 CONTINUE
 610   FORMAT(1X,11F6.0)
C
C SET TIME TO ZERO
C
      TIM=0.
C
C
C SET BREAKPOINT TEST VALUE
C
      BKPT=10.
C
C
C
C
C
C     MAIN LINE PROGRAM
C
C
C CALCULATION OF AMPLIFIER PARAMETERS FROM THE MEASUREMENTS
C
C
C CALC1.  DC ATTENUATION
C
1100       CONTINUE
      IF(M1-2)1100,1110,1100
C  V3=DTA1(1)
C  V4=DTA2(2)
1110       DCATT=DTA1(2)/DTA1(1)
C
      WRITE(9,501)DCATT
501   FORMAT(///1X,"DC ATT =" F10.2)
C
C  CALC2. GAIN TO PT. 5.  AC TO RECTIFIED AVERAAGE
C
C
1200     CONTINUE
      IF(M2-2)1200,1210,1200
 1210    G=0.
      DO 1220  I=1,100
1220     G=G + ABS(DTA2(I))
```

```
C
C  RESCALE G
C
      G=G/1000.
C
       WRITE(9,502)G
 502      FORMAT(///1X,"GAIN TO PT.5=",F10.2)
C
C
C  CALCULATION 3.  POSITIVE THRESH AND CURRENT GEN
C
C USE RAMP DATA; V5 AND V6
C
1300      CONTINUE
      IF(M3-2)1300,1310,1300
C FIND COUNT AT WHICH V6 IS PAST THE BREAK POINT IN CURVE
C
1310     DO 1315 I=2,1000,2
      KOUNT=I
      IF (DTA3(I)-BKPT01315,1320,1320
 1315      CONTINUE
 1320    CONTINUE
C
C
C
C SORT EVERY 50TH VALUE O F V5 & V6 BUT AVERAGE ADJACENT
C VALUES OF V660.
C
      I=0
         DO 1330 K=KOUNT,1000,50
      I=I+1
      V5(I)= DTA3(K-1)
      V6(I)=(DTA3(K)+DTA3(K-2))/2.
1330  CONTINUE
C
      WRITE(9,503)(V5(I),I=1,20)
      WRITE(9,504)(V6(I),I=1,20)
 503    FORMAT(///1X,"V5"/1X,15(5F10.2/1X))
 504    FORMAT(//1X,"V6"/1X,15(5F10.2/1X))
C
C FIND UPPER LIMIT ON  NUMBER OF VALUS OF V5 (SAME NUMBER FOR V6)
C
      NUMB=(1000-KOUNT0/50
      WRITE(9,505)NUMB
 505    FORMAT(///1X,"POS NUM=" I5)
C
C  CALL SUBROUTINE TO OBTAIN LEAST MEAN SQUARE FIT TO LINE
C
         CALL LMSF(NUMB,TP,GP)
C
      WRITE(9,506)TP,GP
 506    FORMAT(///1X,"THRESH=",F10.2/1X,"GAIN=",F10.2)
C
C
C  CALCULATION 4. NEGATIVE THRESH. AND CURRENT GEN.
C
C   USE RAMP DATA . V5 AND V6
C
 1400      CONTINUE
      IF(M4-2)1400,1405,1400
```

```
C
C
C  FIND COUNT AT WHICH V6 IS PAST THE BREAKPOINT
C
1405    DO  1410 I=2,1000,2
        KOUNT=I
        IF(DTA4(I)-BKPT)1410,1420,1420
1410      CONTINUE
C
1420      CONTINUE
C
C
C
C  SORT EVERY 50TH READING OF V5 &V6; AVERAGE
C  ADJACENT VALUES OF V6
C
        I=0
        DO 1430 K=KOUNT,1000,50
        I=I+1
        V5(I)=DTA4(K-1)
        V6(I)=(DTA4(K)+DTA4(K-2))/2.
1430      CONTINUE
C
        WRITE(9,503)(V5(I),I=1,20)
        WRITE(9,504)(V6(I),I=1,20)
C
C FIND NUMBER OF VALUES
        NUMB=(1000-KOUNTO/50
C
        WRITE(9,510)NUMB
 510      FORMAT(///1X,"NEG  NUM=" I5)
C CALL LEAST MEAN SQUARE FIT TO A STRAINGT LINE
C
        CALL LMSF(NUMB,TN, GN)
C
        WRITE(9,506)TN,GN
C
C
C
C  CALCULATION 5. STEP AND IMPULSE RESPONSE
C
C
1500      CONTINUE
        IF (M5-2)1500,1510,1500
C CALCULATE STEP HEIGHT
C
1510      CONTINUE
        CALL DCSTP
        WRITE(9,520) STP
 520    FORMAT(///1X,"STP HEIGHT=" ,F10.2)
C
C  CALCULATE FILTER RESPONSE TO STEP
C
        CALL STEP
        WRITE(9,521)A,P1,P2
 521      FORMAT(///1X,"A=",F10.2/1X,"P1=",F10.2/1X,"P2=",F10.2)
C
C  CALCULATE  IMPULSE RESPONSE
C
        CALL IMPULS
```

```
C
      WRITE(9,522)C,D
 522      FCRMAT(///1X,"C=",F10.2/1X,"D="F10.2)
C
C
C
C  CALCULATION 6. CALCULATE SCR FIRING VOLTAGE
C
C
1600      CONTINUE
      IF(M6-2) 1600,1610,1600
1610    CONTINUE
      CALL SFIRE
C
      WRITE(9,525)FIRE
 525    FORMAT(///1X,"EIRE VOLTAGE=", F10.2)
C
C
C
C
C  RESET AMPLIFIER BY DISCHARGING CONDENSORS
C
C  SHORT C1
C  SHORT C2
C
C UNSHORT C1
C UNSHORT C2
C
C
C
C
C
C  CALCULATE GAIN REQUIRED TO MEET HOB
C
C
C  FIND POLE POSITIONS AND INTERPOLATION FACTORS FOR
C  USE IN LOOKING UP CONVOLUTION INTEGRALS
C
C POLE1
C SCALE POLE VALUE
      P1=P1*SP1
      IP1=P1
        IP1=IP1/NNP1
      PL1=IP1*NNP1
      ALPH1=(P1-PL1)/DELP1
C FIND POSITION IN TABLE
      NP1=IP1-MP1
C
      WRITE(9,530)ALPH1,NP1
 530    FORMAT(///1X,"ALPH1=" ,F10.2/1X,"P1 POSITION IN TABLE=",F10.2)
C
C REPEAT FOR P2
C
      P2=P2*SP2
      IP2=P2
      IP2=IP2/NNP2
        PL2=IP2*NNP2
      ALPH2=(P2-PL2)/DELP2
      NP2=IP2-MP2
C
```

```
C
      WRITE(9,531)ALPH2,NP2
  531   FORMAT(///1X,"ALPH2=" ,F10.2/1X,"P2 POSITION IN TABLE=",F10.2)
C
C
C
C
C
C
C  ITERATIVE LOOP TO FIND REQUIRED GAIN
C
C INITIALIZE
C
      GCALC=GNOM
      KOUNT=0
C
C START OF LOOP
C
 2050  CONTINUE
      KOUNT =KOUNT +1
      WRITE(9,540)KOUNT
  540     FORMAT(///1X,"LOOP COUNT = ",I5)
C
      WRITE (9,546) GCALC
  546    FORMAT(///1X,"CALCULATED GAIN = ",F10.2)
C
C  FIND THRESHOLD POSITIONS AND INTERPOLATION FACTORS
C
C POSITIVE THRESHOLD
C
      PTP=TP/GCALC*100
      ITP=PTP
      ITP=ITP/10
      TPL=ITP*10
      BETP=(PTP-TPL)/10.
      NPT=ITP+1
C
C
      WRITE(9,541)BETP,NPT
 541  FORMAT(///1X,"BETA POSITIVE=",F10.2/1X,"THRESH POSITION=",F10.2)
C
C
C
C NEGATIVE THRESHOLD
C
      PTN=TN/GCALC*100
      ITN=PTN
      ITN=ITN/10
      TNL=ITN*10
      BETN=(PTN-TNL)/10.
      NNT=ITN+1
C
C
C
      WRITE(9,542)BETN,NNT
  542     FORMAT(///1X,"BETA NEG=",F10.2/1X,"THRESH POSITION=",F10.2)
C
C
C
C  CALCULATE THE FOUR PORTIONS OF THE CONVOLUTION INTEGRAL
```

```
C
      CALL INTGRL(NP1,NPT,ALPH1,BETP,C1P)
       CALL INTGRL(NP2,NPT,ALPH2,BETP,C2P)
      CALL INTGRL(NP1,NNT,ALPH1,BETN,C1N)
      CALL INTGRL(NP2,NNT,ALPH2,BETN,C2N)
C
      SUM1=GP*(C*C1P+D*C2P)
      SUM2=GN*(C*C1N+D*C2N)
      SUM=GCALC*(SUM1+SUM2)
      WRITE(9,545) C1P,C2P,C1N,C2N,SUM
 545    FORMAT(///1X,"INTEGRALS"/1X"POLE  1,POS THRESH=",F10.2/1X,
     1" POLE 2, POS THRESH=",F10.2
     2/1X,"POLE 1,NEG THRESH=",F10.2/1X,
     3 "POLE 2,NEG THRESH =",F10.2//1X,"SUM = ",F10.2)
      TEMP=(SUM-FIRE)/FIRE
      TEMP=ABS(TEMP)
      IF(TEMP-0.0005)2000,2000,2100
2100       IF(KOUNT-10)2110,9999,9999
C CONTINUE ITERATIONS
C
2110    GCALC=GCALC*(FIRE/SUM)
        GO TO 2050
C
C
C
C
C  SUCCESSFUL EXIT FROM LOOP
C
 2000    CONTINUE
C
      WRITE(9,710)
 710    FORMAT(///1X,"SUCCESSFUL CALC OF GAIN")
C
C
C
C
C  CALCULATE RESISTOR TRIM
C
C RS/R=(KS/(1-KS)*(K/(4-K))
C  RS/R=(GCALC/G)*(1-H)/(1-GCALC*H/G)
C
      TEMP=GCALC/G
      PCHNG=TEMP*(1.-DCATT)
      PCHNG=PCHNG/(1.-TEMP*DCATT)
C
C
      WRITE(9,550)TEMP,PCHNG
  550    FORMAT(///1X,"RATIO OF CALC GAIN TO ACTUAL GAIN = ",F10.2
     1 /1X, "RATIO OF FINAL TRIM R VALUE TO PRESENT VALUE = ",F10.2)
C
C
      CALL LNGTH(PCHNG)
C
C
C
C
C
C
      WRITE(9,560)CUT
560    FORMAT(///1X,"LENGTH OF CUT=",F10.2)
```

```
C
C
C
C       CUT TO LENGTH GIVEN BY SUBROUTINE
C    IDLE TILL CUT IS COMPLETE
C
C
C   FINAL TRIM.  MONITOR GAIN DURING TRIM
C
C    OUTPUT CW
C    ORDER READ OF V5
C
C KCUNTR= WCRD COUNT FROM CHANNEL I/O.NUMBER OF WORDS
C ALREADY READ IN
C
C
C   ACCUMULATE THE SUM OF THE FIRST 20 WORDS
C
C
C
C
C
C
C
C
C
C
C
C
C
C
         KTEMP = 1
        SUM=0.
        DO 2640 I=1,20
 2630     CONTINUE
        IF (KOUNTR-KTEMP)2630,2635,2635
 2635     SUM=SUM+ABS(DTA2(I))
        KTEMP=KTEMP+1
 2640     CONTINUE
C
C
C
C ORDER CUT
C
C   MONITOR GAIN
C
        DO 2650 I=21,1000
 2600     CONTINUE
        IF(KOUNTR-KTEMP)2600,2610,2610
 2610     KTEMP=KTEMP+1
        SUM = SUM -ABS(DTA2(I-20))+ABS(DTA2(I))
        IF(SUM-GCALC)2650,2660,2660
 2650     CONTINUE
C  PROGRAM HAS FAILED TO ACHIEVE  REQUIRED GAIN WITHIN
C  THE READ TIME LIMITS
C
        GO TO 999
C
C  PROGRAM HAS SUCCEEDED IN TRIMMING AMP TO TOREQUIRED HOB
C
```

```
C
 2660       GO TO 10000
C
C
C
C
C
C
C
C
C
C
C
10000     CONTINUE
           WRITE (9,1)
1        FORMAT(///1X,"PROGRAM HAS SUCCEEDED IN ACHIEVING"
        1 "REQUIRED HOB")
         GO TO 10001
C
C
999       CONTINUE
         WRITE(9,998)
998        FORMAT(///1X,"PROGRAM HAS FAILED TO ACHIEVE THE REQUIRED"
        1" GAIN WITHIN THE REAL TIME LIMITS")
         GO TO 10001
C
C
C
9999       CONTINUE
         WRITE(9,9998)
9998       FORMAT(///1X,"HOB GAIN CALCULATIONS FAILED TO CONVERGE"
        1 "IN TEN ITERATIONS")
         GO TO 10001
C
C
C
C
10001          CONTINUE
C
         WRITE (9,570)
 570       FORMAT(///1X,"PROGRAM HAS RUN TO COMPLETION")
C
         LOCK 6
         STOP
         END
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
```

```
C
C
C
C   SUBROUTINES
C
      SUBROUTINE LMSF(NUMB,T,GAIN)
C  LEAST MEAN SQUARE FIT TO A STRAIGHT LINE
C
C
C  DATA DEFINITIONS
C
       COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(100)
      COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
      COMMON M1,M2,M3,M4,M5,M6
C
      COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
      COMMON CUT,TIM
C
C
C
      A12=0.
      A22=0.
      B1=0.
      B2=0.
C
      N=NUMB
      DO 12 I=1,N
      A12=A12+V5(I)
      A22=A22+V5(I)*V5(I)
      B1=B1+V6(I)
      B2=B2+V5(I)*V6(I)
12     CONTINUE
C
      A11=NUMB
C
C
C
      F=A11*A22-A12*A12
      TEMP=A22*B1-A12*B2
      TEMP=TEMP/F
      GAIN=A12*B1-A11*B2
      GAIN=-GAIN/F
      T=-TEMP/GAIN
C
C
      GAIN=ABS(GAIN)
      T=ABS(T)
C
C
C
C
C
C  RESCALE GAIN AND THRESHOLD
C
      GAIN=GAIN/10.
      T=T*0.15
C
C
C
C
```

```
C
C
      RETURN
      END
C
C
C
C
C
      SUBROUTINE DCSTP
C CALCULATE HEIGHT OF STEP
C
C
C  DATA DEFINITIONS
C
       COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(100)
      COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
      COMMON M1,M2,M3,M4,M5,M6
C
      COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
      COMMON CUT,TIM
C
C
C
        STP=10.
C
       RETURN
      END
C
C
C
C
        SUBROUTINE STEP
C CALCULATE STEP RESPONSE
C
C
C  DATA DEFINITIONS
C
       COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(100)
      COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
      COMMON M1,M2,M3,M4,M5,M6
C
      COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
      COMMON CUT,TIM
C
C
C
      A=5
      P1=22.5
      P2=32.5
C
       RETURN
      END
C
C
C
      SUBROUTINE IMPULS
C CALCULATE IMPULSE RESPONSE
C
C
```

```
C  DATA DEFINITIONS
C
        COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(100)
       COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
       COMMON M1,M2,M3,M4,M5,M6
C
       COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
       COMMON CUT,TIM
C
C
C
       C=2.
       D=2.
C
C
       RETURN
       END
C
C
C
C
C
         SUBROUTINE SFIRE
C  CALCULATE FIRE VOLTAGE OF SCR
C
C
C  DATA DEFINITIONS
C
        COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(100)
       COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
       COMMON M1,M2,M3,M4,M5,M6
C
       COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
       COMMON CUT,TIM
C
C
C
       FIRE=8000.
C
C
       RETURN
       END
C
C
C
       SUBROUTINE INTGRL(I,J,ALPH,BET,CI)
C
C
C  DATA DEFINITIONS
C
        COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(100)
       COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
       COMMON M1,M2,M3,M4,M5,M6
C
       COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
       COMMON CUT,TIM
C
C
C
C  FIND INTEGRAL BY INTERPOLATION OF TABLE VALUES
```

```
C
      CI=CON(I,J)
     1 +BET*(CON(I,J+1)-CON(I,J))+ALPH*(CON(I+1,J)-CON(I,J))
     1 +ALPH*BET*(CON(I+1,J+1)-CON(I+1,J)-CON(I,J+1)+CON(I,J))
C
C
      RETURN
      END
C
C
C
C
C
      SUBROUTINE LNGTH(PCHNG)
C
C
C  DATA DEFINITIONS
C
       COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(10))
      COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
      COMMON M1,M2,M3,M4,M5,M6
C
      COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
      COMMON CUT,TIM
C
C
C
      CUT=17.
C
C
      RETURN
      END
C
C
C
CC
C
      SUBROUTINE CLK
C RECORD TIME AND EVENT
C
C
C
C  DATA DEFINITIONS
C
       COMMON DTA1(100),DTA2(1000),DTA3(1000),DTA4(1000),DTA5(10))
      COMMON DTA6(1000),V5(100),V6(100),CON(30,11)
      COMMON M1,M2,M3,M4,M5,M6
C
      COMMON IMAX, G,STP,A,B,C,D,P1,P2,FIRE
      COMMON CUT,TIM
C
C
C
      RETURN
      END
C
C
C
C
C
```

APPENDIX C

PRINTOUTS USING SIMULATION OF REAL-TIME AMPLIFIER TEST PROGRAM AND SIMULATED AMPLIFIER DATA

ID	NAME
1	DC ATTEN
2	RECTIFIED AVERAGE
3	POSITIVE THRESH AND CUR. GEN
4	NEGATIVE THRESH AND CUR. GEN.
5	STEP RESPONSE
6	SCR FIRING VOLTAGE

DC ATTENUATION

5.00	1.00

DATA FOR POINT 5 VOLT

10.00	-10.00	10.00	-10.00	10.00	-10.00
10.00	-10.00	10.00	-10.00		

POSITIVE RAMP DATA

1.00	-80.00	3.00	-60.00	5.00	-40.00
7.00	-20.00	9.00	0.00	11.00	20.00
13.00	40.00	15.00	60.00	17.00	80.00

NEGATIVE RAMP DATA

-1.00	-80.00	-3.00	-60.00	-5.00	-40.00
-7.00	-20.00	-9.00	0.00	-11.00	20.00
-13.00	40.00	-15.00	60.00	-17.00	80.00

STEP RESPONE

1.00	2.00	3.00	4.00	5.00	6.00
7.00	8.00	9.00	10.00	11.00	12.00

FIRE VOLTAGE DATA

1.00	2.00	3.00	4.00	5.00	6.00
7.00	8.00	9.00	10.00	11.00	12.00

TABLE OF CONVOLUTION INTEGRALS

100.	99.	98.	97.	96.	95.	94.	93.	92.	91.	90.
101.	100.	99.	98.	97.	96.	95.	94.	93.	92.	91.
102.	101.	100.	99.	98.	97.	96.	95.	94.	93.	92.
103.	102.	101.	100.	99.	98.	97.	96.	95.	94.	93.
104.	103.	102.	101.	100.	99.	98.	97.	96.	95.	94.

DC ATT = 0.20

GAIN TO PT.5= 1.00

V5

11.00	61.00	111.00	161.00	211.00
261.00	311.00	361.00	411.00	461.00
511.00	561.00	611.00	661.00	711.00
761.00	811.00	861.00	911.00	961.00

V6

10.00	510.00	1010.00	1510.00	2010.00
2510.00	3010.00	3510.00	4010.00	4510.00
5010.00	5510.00	6010.00	6510.00	7010.00
7510.00	8010.00	8510.00	9010.00	9510.00

POS NUM= 19

THRESH= 1.50
GAIN= 1.00

V5

-11.00	-61.00	-111.00	-161.00	-211.00
-261.00	-311.00	-361.00	-411.00	-461.00
-511.00	-561.00	-611.00	-661.00	-711.00
-761.00	-811.00	-861.00	-911.00	-961.00

V6

10.00	510.00	1010.00	1510.00	2010.00
2510.00	3010.00	3510.00	4010.00	4510.00
5010.00	5510.00	6010.00	6510.00	7010.00
7510.00	8010.00	8510.00	9010.00	9510.00

```
NEG  NUM=   19


THRESP=       1.50
GAIN=      1.00


STP HEIGHT=      10.00


A=       5.00
P1=      22.50
P2=      32.50


C=       2.00
D=       2.00


FIRE VOLTAGE=   8000.00


ALPH1=       0.50
P1 POSITION IN TABLE=       1.00


ALPH2=       0.50
P2 POSITION IN TABLE=       3.00


LOOP COUNT =      1


CALCULATED GAIN =        5.00


BETA POSITIVE=       1.00
THRESH POSITION=      3.00


BETA NEG=      1.00
THRESH POSITION=      3.00


INTEGRALS
POLE  1.POS THRESH=      97.50
 POLE 2. POS THRESH=      99.50
POLE 1.NEG THRESH=      97.50
```

POLE 2,NEG THRESH = 99.50

SUM = 3940.00

LOOP COUNT = 2

CALCULATED GAIN = 10.15

BETA POSITIVE= 0.48
THRESH POSITION= 2.00

BETA NEG= 0.48
THRESH POSITION= 2.00

INTEGRALS
POLE 1,POS THRESH= 99.02
POLE 2, POS THRESH= 101.02
POLE 1,NEG THRESH= 99.02
POLE 2,NEG THRESH = 101.02

SUM = 8123.65

LOOP COUNT = 3

CALCULATED GAIN = 10.00

BETA POSITIVE= 0.50
THRESH POSITION= 2.00

BETA NEG= 0.50
THRESH POSITION= 2.00

INTEGRALS
POLE 1,POS THRESH= 99.00
POLE 2, POS THRESH= 101.00
POLE 1,NEG THRESH= 99.00
POLE 2,NEG THRESH = 101.00

SUM = 7998.17

```
SUCCESSFUL CALC OF GAIN


RATIO OF CALC GAIN TO ACTUAL GAIN =        10.00
RATIO OF FINAL TRIM R VALUE TO PRESENT VALUE =        -8.00


LENGTH OF CUT=      17.00


PROGRAM HAS SUCCEEDED IN ACHIEVINGREQUIRED HOB


PROGRAM HAS RUN TO COMPLETION
```

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(9) Quarterly progress rept. no. 3,
11 Nov 76 — 10 Feb 77.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER (6)

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
Production Measurement of Fuze Components Under Dynamic Stress.

5. TYPE OF REPORT & PERIOD COVERED
Third Quarterly Progress Report 11 Nov 76 - 10 Feb 77

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s) (10)
A. J. Eisenberger
P. Kaszerman

8. CONTRACT OR GRANT NUMBER(s) (15)
DAAB07-76-C-0032

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Lockheed Electronics Co., Inc.
U.S. Highway 22
Plainfield, N.J. 07061

210050
A036251

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
2759665

11. CONTROLLING OFFICE NAME AND ADDRESS
Department of the Army
U.S. Army Electronics Command
Ft. Monmouth, N.J. 07703

12. REPORT DATE (11)
9 March 1977

13. NUMBER OF PAGES
56 (12) 64p.

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
Prod and Proc Directorate
DRSEL-PP-I-PI-1

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release, distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
(10) Arthur J. Eisenberger
Philip Kaszerman

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Laser Trim
Computer Test
Functional Test

#1, A036251

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

During the third quarter, the major components of the test station were built, assembled, and successfully checked out at the vendors' plants. These components consisted of the following subsystems: Computer Control, Stimulus, Measurement, Interface and Laser Trimmer. The first four subsystems were integrated and checked as a total system by Hewlett-Packard.

210050

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)